Engineering Evaluation/Cost Analysis

Midway Atoll National Wildlife Refuge
Midway Island

for
U.S. Fish and Wildlife Service

January 18, 2011

GeoEngineers
Earth Science + Technology

Engineering Evaluation/Cost Analysis

Midway Atoll National Wildlife Refuge
Midway Island

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EXECUTIVE SUMMARY

GeoEngineers completed an Engineering Evaluation/Cost Analysis (EE/CA) for lead contaminated soil at the Midway Atoll National Wildlife Refuge (Midway, Refuge or site) for the U.S. Fish and Wildlife Service (FWS). Historical structures at the site were typically painted with lead-based paint (LBP).

The overall objective of this EE/CA was to evaluate various cleanup alternatives and to select the best alternative to provide a long-term, effective remedy that will reduce potential risks to ecological health. Additional objectives of the EE/CA are to identify alternatives that comply with federal and state environmental laws, are cost effective, and use permanent solutions and innovative treatment technologies to the extent practicable.

For this EE/CA, the site was divided into nine Decision Units, which will allow for the FWS to prioritize remediation activities at the areas presenting the highest threats and in the most cost-effective manner.

GeoEngineers collected 694 soil samples from 230 sample locations throughout the site as part of the EE/CA. The sampling and subsequent chemical analysis were completed to identify the nature and extent of the soil contamination.

GeoEngineers also completed a streamlined risk evaluation (SRE) for the site. The SRE determined that the preliminary cleanup goal (PCG) for lead in soil at the site is 75 milligrams per kilogram (mg/kg). The PCG was selected based on multiple lines of evidence including: 1) a dietary lead/blood lead correlation; 2) an avian exposure model; and 3) an evaluation of existing site soil lead/avian blood lead data.

The EE/CA was conducted in the following four main steps:

- **Identification of Removal Action Objectives:** Removal action objectives describe what a removal action is designed to achieve. The removal action objectives were evaluated to make sure they met applicable laws and regulations.
- **Identification and Screening of Applicable I Response Technologies**: General response technologies that can be used to satisfy the removal action objectives were developed. For example, in-place management of contaminated soil is a general response action. This can be accomplished through Land Use Controls (LUCs), which are legal, administrative, or physical constraints that restrict or control access to sites. Containment by covering or capping the wastes to physically prevent access is also considered, along with excavation and removal of wastes. Various options associated with each technology were developed. The technologies and options were screened for overall short-term and long-term effectiveness, implementability and cost.
- **Development of Removal Action Alternatives**: Removal action alternatives for the site were developed by combining response technologies and options.
- **Detailed Analysis of Alternatives**: A detailed analysis of the alternatives was conducted to select the best alternative. Each alternative was evaluated against the following criteria:

- Overall protection of human health and the environment (including wildlife)
- Compliance with applicable laws and regulations
- Long-term effectiveness
- Reduction in contaminant toxicity, mobility and volume through treatment
- Short-term effectiveness
- Implementability
- Cost of implementation

The following is a summary of the recommended alternative for each Decision Unit.

- Decision Unit 1, Alternative #3 – Abatement of lead on Building 643 and the demolition of the remaining structures with limited excavation of soil with lead at concentrations above the PCG and the installation of a geomembrane and a soil cap. On-site disposal of the demolition debris and soil using ex-situ soil stabilization methods in a consolidation unit. Estimated cost - $853,008. Alternative #6 should be considered if storage space in the proposed R2 consolidation unit becomes an issue.
- Decision Unit 2, Alternative #3 – Removal of asbestos transite siding from the structures, demolition of the structures and excavation of soil with lead at concentrations above the PCG. On-site disposal of the contaminated soil and demolition debris using ex-situ soil stabilization methods in a consolidation unit. Estimated cost - $1,304,216.
- Decision Unit 3, Alternative #3 – Abatement of lead on the exterior of Buildings 4203 and 4212 with excavation of soil with lead at concentrations above the PCG. On-site disposal of the contaminated soil using ex-situ soil stabilization methods in a consolidation unit. Estimated cost - $733,215.
- Decision Unit 4, Alternative #3 – Abatement of lead on the exterior of Buildings 259, 2403, and 2404 with the excavation of soil with lead at concentrations above the PCG. On-site disposal of the contaminated soil using ex-situ soil stabilization methods in a consolidation unit. Estimated cost - $598,084.
- Decision Unit 5, Alternative #3 – Abatement of lead on the exterior of Buildings 5309 and 5303 with the excavation of soil with lead at concentrations above the PCG. On-site disposal of the contaminated soil using ex-situ soil stabilization methods in a consolidation unit. Estimated cost - $552,001.
- Decision Unit 6, Alternative #3 – Abatement of lead on the exterior the buildings with limited excavation of soil with lead at concentrations above the PCG and the installation of a geomembrane and a soil cap. On-site disposal of the contaminated soil in using ex-situ soil stabilization methods in a consolidation unit. Estimated cost - $1,472,093. Alternative #6 should be considered if storage space in the proposed R2 consolidation unit becomes an issue.
- Decision Unit 7, Alternative #3 – Abatement of lead on the exterior the buildings with the excavation of soil with lead at concentrations above the PCG. On-site disposal of the contaminated soil using ex-situ soil stabilization methods in a consolidation unit. Estimated cost - $784,899.

- Decision Unit 8, Alternative #3– Decommissioning of the above ground storage tanks (AST) by removal with excavation of soil with lead at concentrations above the PCG. On-site disposal of the contaminated soils using ex-situ soil stabilization methods in a consolidation unit. Estimated cost - $634,232.
- Decision Unit 9, Alternative #3 – Abatement of lead from the exterior of the structures with limited excavation of soil with lead at concentrations above the PCG and the installation of a geomembrane and a soil cap. On-site disposal of the contaminated soil using ex-situ soil stabilization methods in a consolidation unit. Estimated cost - $1,867,251.

The following is a summary of the total estimated costs for all decision units, by alternative chosen:

- Alternative #2 - $8,659,974. If Alternative #6 is chosen for Decision Units 1 and 6 the estimated cost is $8,871,373.
- Alternative #3 - $9,098,999. If Alternative #6 is chosen for Decision Units 1 and 6 the estimated cost is $9,215,241.
- Alternative #5 - $14,688,933. If Alternative #6 is chosen for Decision Units 1 and 6 the estimated cost is $15,760,554.

The Decision Units with the highest potential to affect wildlife are Decision Unit 1, Decision Unit 6 and Decision Unit 2 based on the 2010 analytical results for lead in soil, and the condition of the exterior paint on each structure. The following is the ranking of risk for the Decision Units.

1. Decision Unit 1
2. Decision Unit 6
3. Decision Unit 2
4. Decision Unit 4
5. Decision Unit 7
6. Decision Unit 5
7. Decision Unit 3
8. Decision Unit 8
9. Decision Unit 9

1.0 INTRODUCTION

This report presents the results of the Engineering Evaluation/Cost Analysis (EE/CA) completed by GeoEngineers, Inc. (GeoEngineers) for lead contaminated soil and paint at the Midway Atoll National Wildlife Refuge (Midway, Refuge or site). This report has been prepared for the U.S. Fish and Wildlife Service (FWS) under Delivery Order Number 101819X716.

This EE/CA follows the Comprehensive Environmental Restoration, Compensation, and Liability Act (CERCLA) process. The FWS is addressing the lead contamination issues at the site in accordance with the CERCLA process as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986. This EE/CA has been prepared in accordance with the U.S. Environmental Protection Agency (EPA) Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA (EPA, August 1993). An EE/CA is similar to a Focused Feasibility Study (FS) in which limited appropriate alternatives are evaluated (EPA, August 1993).

For this EE/CA, the site was divided into Decision Units, which will allow for the FWS to prioritize remediation activities at the areas presenting the highest threats and in the most cost-effective manner. The Decision Units are shown on Figure 2A. The Decision Units include:

- Decision Unit 1 – Buildings 619, 623, 626, 628, 643 (Cable Buildings) and the soils surrounding the structures.
- Decision Unit 2 – Buildings 578, 579 (Marine Barracks) and the soils surrounding the structures.
- Decision Unit 3 – Building 4203 (Bachelors Office Quarters [BOQ] Bravo Barracks), Building 4212, and the lead contaminated soil in the vicinity of Buildings 4203, 4204, the Officers Quarters buildings 415, 416, 417, 418, 419, 421, 422, 423 and 424, residential duplexes including buildings 4209, 4210, 4211 and 414. The exterior LBP has been removed and/or encapsulated for all the buildings in this Decision unit, except Buildings 4203 and 4212.
- Decision Unit 4 – Building 259 (Midway Mall), Buildings 2403 and 2404.
- Decision Unit 5 – Building 5309 (the former Transmitter building) and 5303 (R2 Unit)
- Decision Unit 6 – Buildings 393 (SKI warehouse,) 342 (hazardous materials storage), 356 (Transportation shop), 357 (Machine shop), Building 353 (carpenter shop) 349 (Cold storage), 363 (Torpedo shop/recycling) and 151 (Seaplane Hangar).
- Decision Unit 7 – Buildings 331 (Medical Clinic/Offices), 3502 (Galley), 3503 (Barracks C), 3504 (Barracks D) and 3512 (Gymnasium).
- Decision Unit 8 – Fuel storage tanks located at the old fuel farm.
- Decision Unit 9 – The remaining buildings or structures that are in use by the FWS, except for the water storage tanks near the airport. Decision Unit 9 originally included the water storage tanks near the airport. Through a separate action, FWS will be coating the water tanks with a lead encapsulating paint. As such, GeoEngineers has not addressed the water tanks in this EE/CA.

1.1. Objectives

The objectives of this EE/CA are to identify the goals of a removal action, to evaluate potential removal action alternatives (RAA), and to recommend the most appropriate response approach to address risks associated with the lead contaminated soil. To satisfy the EPA criteria, the selected RAA must:

- Protect human health and the environment;
- Comply with applicable or relevant and appropriate requirements (ARARs) of federal and state environmental laws;
- Be cost-effective;
- Use permanent solutions and innovative treatment technologies to the extent practicable; and
- Satisfy the regulatory preference for treatment that reduces contaminant toxicity, mobility, or volume.

With input from the public, the FWS will use the above objectives together with this EE/CA and documents in the administrative record to select an appropriate RAA. After responding to public comments on the EE/CA, the selected remedy will be formally documented in an Action Memorandum in accordance with the National Oil and Hazardous Substances Contingency Plan (NCP).

To meet the objectives, the scope of this EE/CA included the following:

- Identify a list of proven technologies and process options, which address the removal action objectives (RAOs);
- Screen the technologies and process options according to effectiveness, implementability and cost;
- Assemble the retained technologies and process options into the most feasible removal actions; and
- Provide a detailed comparative analysis of each alternative's ability to satisfy criteria discussed in 40 Code of Federal Regulations (CFR 300.415[b][2]).

1.2. Report Organization

This EE/CA report consists of six sections:

- Section 1: **Introduction** describes the background of this EE/CA and states the objectives and scope.
- Section 2: **Site Characterization** presents background information, including site location, historical and current land use, geology, hydrology and sensitive ecosystems present at the site. This section also summarizes the historical field investigation results.
- Section 3: describes GeoEngineers **2010 Field Investigation**.
- Section 4: Describes the **Source, Nature and Extent of Contamination** at the site.
- Section 5: Provides a summary of the **Streamlined Risk Assessment** completed for the site.

- Section 6: **Identification of Removal Action Objectives** (RAOs) describes Preliminary Cleanup Goals that are intended to provide adequate protection of human health and the environment, and describes contaminated areas at the site.
- Section 7: **Identification and Screening of Response Action Technologies** describes general response actions that address RAOs, identifies and screens removal action technologies and process options, and introduces the identification and more detailed screening of removal action alternatives for lead contamination.
- Section 8: **Development of Removal Action Alternatives** provides a detailed discussion of the applicable alternatives for the site.
- Section 9: **Comparison of Removal Action Alternatives** presents a detailed analysis of the potential removal actions remaining after the screening process using the evaluation criteria listed in 40 CFR 300.415(b) and also provides a comparative analysis of the alternatives.
- Section 10: **Recommended Removal Action Alternative** providing a summary of the recommendations for the nine Decision Units.
- Section 11: **References** lists the references used in the preparation of this document.

2.0 SITE CHARACTERIZATION

This section summarizes information pertaining to the lead contamination at the site, including site location and history, physical setting of the site, previous investigations, nature and extent of the contamination and results of the ecological risk evaluations that have been conducted for the site.

2.1. Site Location and Description

The Refuge is a United States possession located in the Northwestern Hawaiian Islands at 28°12'35'' North latitude and 177°22'47'' West longitude, approximately 1,250 miles northwest of Oahu, at the northwestern end of the Hawaiian Island chain (Figure 1). The real property, on which the Refuge exists, as well as all operational facilities, was formerly known as Naval Air Facility (NAF) Midway Island. NAF Midway Island, under the control and jurisdiction of the U.S. Department of Navy, was transferred to the U.S. Department of the Interior (DOI), FWS, on October 31, 1996 and the last contingent of Navy personnel left on June 30, 1997.

The Refuge consists of three islands and a lagoon, enclosed by a circular coral reef (atoll) approximately five miles in diameter, and is surrounded on all sides by the Pacific Ocean. The largest island, Sand Island, has an area of about 1,100 acres, and has a permanent population that varies from 30 to 100 people. Eastern Island has an area of about 334 acres and has been uninhabited since 1970. Spit Island is an ephemeral sand spit with a current area of approximately 14 acres, and has never been inhabited.

All Refuge operational facilities are located on Sand Island. The facilities consist of an airfield, single and multi-unit residences, dining and recreational facilities, and support facilities. A layout of Sand Island is shown in Figure 2.

The Secretary of the Interior, through the United States Fish and Wildlife Service, shall administer the Midway Islands as the Midway Atoll National Wildlife Refuge in a manner consistent with Executive Order 12996 of March 25, 1996, for the following purposes:

- Maintaining and restoring natural biological diversity within the refuge;
- Providing for the conservation and management of fish and wildlife and their habitats within the refuge;
- Fulfilling the international treaty obligations of the United States with respect to fish and wildlife;
- Providing opportunities for scientific research, environmental education, and compatible wildlife dependent recreational activities; and
- In a manner compatible with refuge purposes, shall recognize and maintain the historic significance of the Midway Islands consistent with the policy stated in Executive Order 11593 of May 13, 1971.

On June 15, 2006, President George W. Bush signed Presidential Proclamation 8031 under the authority of the Antiquities Act and created the Papahanaumokuakea Marine National Monument. The monument covers nearly 141,000 square miles of land and ocean and includes Midway Atoll. The Monument adds an additional layer of protection to the refuge.

2.2. Site History

Historical structures at the site typically were painted with lead-based paint (LBP). The FWS is currently undertaking the abatement of LBP on the structures. The ongoing abatement process does not address LBP residue on or in soil surrounding existing buildings. Lead in soil represents a hazard to populations of nesting birds, particularly the Laysan Albatross and Bonin Petrel. The effects on endangered Laysan ducks are not known.

2.3. Physical Setting

2.3.1. Topography

The surface of Midway consists of a variety of open spaces, grassy areas, buildings, concrete and other surface improvements. The majority of the site is relatively flat with little topographic relief.

2.3.2. Meteorology

The climate at Midway Atoll is subtropical. Temperatures range from about 50 degrees Fahrenheit (°F) to 100°F, and average about 73°F. Temperatures below 60°F or above 85°F are rare regardless of season or time of day.

East-northeasterly trade winds predominate from March through November. During the rest of the year, the trade-wind pattern is often interrupted by cyclonic winter storms. Winds average about 10 miles per hour and range up to about 60 miles per hour. Humidity is usually relatively high, with dew point temperatures ranging from 34 to 82°F and averaging 73°F.

Precipitation normally occurs as rain, ranging from mist to moderately intense. Total monthly rainfall ranges up to about 7.5 inches. Average annual rainfall is approximately 25 inches.

2.3.3. Geology

Midway Atoll is a ring-shaped coral reef enclosing a lagoon that is about 5 miles wide. Within the lagoon are two large islands comprised of calcareous sand (Sand Island and Eastern Island). The actions of reef-building coral maintain the atoll's elevation within a narrow range near the sea level. The interior islands were likely formed by coral sand deposited by ocean currents and storms.

The atoll and lagoon islands are underlain by hundreds of feet of limestone that result from millions of years of reef building by coral colonies like those now at and near the surface. A test boring drilled in 1965 on Sand Island penetrated 516 feet of limestone to reach olivine basalt (Ladd, 1970). Another test boring in the lagoon reached basalt at 1,261 feet. The basalt is the result of volcanic eruptions that were similar to ongoing eruptions that continue to build the islands of Hawaii. Midway is near the northwestern end of a line of islands and seamounts (submerged islands) that extend eastward to the island of Hawaii. The further westward from Hawaii, the older are the islands and seamounts. Over time, the islands subsided beneath sea level, and coral reefs that began to fringe the islands eventually became atolls and shoals as their volcanic bases sank deeper.

2.3.4. Soils

Soils to the maximum depths explored consist of calcareous sands with varying amounts of silt and gravel. The uppermost 6 inches of soil typically contains significant amounts of organic debris from vegetation and guano.

During a previous investigation by GeoEngineers, samples were analyzed for general soil parameters, including total organic carbon (TOC), soil moisture content and specific gravity. In summary, moisture contents ranged from 2.8 percent to 22 percent, TOC ranged from 0.09 percent to 3.9 percent and analytical testing using ASTM International (ASTM) Standard Practice D 1557 methods indicated that the soil would be classified as a brown-tan poorly graded clean coral sand (SP). In addition, the porosity of the site soils was calculated using percent moisture contents in the soil samples. The calculated porosities for the soils ranged from 34.3 percent to 37.3 percent. The average porosity was 35 percent.

2.3.5. Hydrology

Rainfall occurs throughout the year generally in the form of light intermittent showers. Rainfall infiltrates the ground surface and percolates to the underlying groundwater aquifer. Soils beneath the sea level (approximately 6 to 8 feet below grade) are saturated with water that has migrated into pore spaces from the surrounding ocean plus percolating rain water that tends to freshen the uppermost portion of the groundwater aquifer. The shallow groundwater aquifer is brackish and tends to decrease in salinity with distance from the nearest shoreline. Groundwater from percolating rain water accumulating in interior areas of the islands cause flow towards the shore where it discharges into the ocean, although the gradients and flux are small.

Water supply for Sand Island is currently obtained by collecting rain in catchment systems. In the past, a salt water desalination system provided water for housing and fire protection, and brackish groundwater was used to augment the catchment system when catchment levels were low. The brackish water and desalination systems have both been abandoned for many years.

The only current use of groundwater on Sand Island is to supply water to wetlands for Laysan ducks. It is unlikely that groundwater will be used in the future for any other purposes (especially drinking water), because rain water catchment is a more than adequate source for the small human population that is expected to be residing on Sand Island for the foreseeable future.

2.3.6. Ecology

Midway is characterized by flora consisting of ironwood trees (*Casuarina equisetifolia*) and other vegetation, including various forbs, grasses and shrubs, (e.g., bunch grass, *Eragrostis variabilis*). Birds common to this area include Laysan and black-footed albatross (*Phoebastria immutabilis and Phoebastria nigripes*, respectively) and bonin petrel (*Pterodroma hypoleuca*) in addition to other shorebirds and seabirds.

Midway provides a unique habitat for both threatened and endangered (T&E) and non-T&E species. Petrels prefer to burrow into soil generally associated with bunch grass and also under stands of ironwood, according to Seto and O'Daniel (1999).

2.4. Previous Investigations and Cleanups

Numerous environmental investigations and response actions have been performed across Sand and Eastern Islands. Much of this work occurred during the transfer of Midway from the U.S. Navy to the FWS. The majority of the work was completed by Ogden Environmental and Energy Service (Ogden) and OHM Remediation Services Corporation (OHM). The following is a brief summary of previous investigations that have focused on lead contamination.

2.4.1. Lead in Soil Research

Death of Laysan albatross chicks, from LBP around buildings at Midway Atoll, was first officially documented based on research that began in 1983 that was published in the 1987 Journal of Wildlife Disease (Seleo et al., 1987).

In 1994, Ogden completed a LBP and asbestos survey of all structures on Eastern and Sand Islands. The Ogden report indicates that as many as 85 percent of the structures on Sand Island contained LBP (Ogden, 1994).

2.4.2. Lead Exposure in Laysan Albatross Adults and Chicks

Laysan albatross adults and chicks were sampled from 1993 through 1995 and were found to have elevated lead levels. Laysan Albatross chicks were found to have LBP chips in their stomachs and have high blood lead levels; “Laysan Albatross adults had minimal to no lead exposure” (Work et al., 1996 and 1998).

2.4.3. Comprehensive Long-Term Environmental Action Navy (CLEAN)

The Base Realignment and Closure (BRAC) Cleanup Plan provided a summary of the environmental status of NAF Midway Island as of 1996 (Ogden, 1997). The BRAC Cleanup Plan covered a number of contaminant issues, with limited discussion of LBP. The BRAC Cleanup Plan did provide a summary of buildings with LBP. The BRAC Cleanup Plan noted that the background level of lead in surface soils had a median concentration of 6.28 milligrams per kilogram (mg/kg) with a maximum concentration of 105 mg/kg. For subsurface soils, the median was 0.4 mg/kg with a maximum

concentration of 171 mg/kg (Ogden, 1996). The BRAC closure report summarized the results of Ogden's Site Investigation Report dated January 2006 (Ogden, 2006) and Ogden's Remedial Investigation (RI) report dated, March 1997.

2.4.4. Year 2000 and 2001 Investigations

A study conducted in 2000 and 2001 found isotopic agreement between lead in blood and LBP chips and showed that lead-containing paints from decommissioned military buildings on Midway serve as a significant source of lead poisoning to Laysan albatross. The route of exposure to lead poisoned birds was primarily through direct ingestion of LBP chips and not from lead contaminated soil (Finkelstein et al., 2003).

2.4.5. Year 2004 Investigations

The FWS estimated the LBP abatement and building removal cost at Midway at approximately $55 million. Consultants recommended that any debris with LBP and asbestos be disposed of on-island, to reduce costs, and that the debris be capped with 12 inches of asphalt grindings and 12 inches of soil (Finkelstein, 2004).

The FWS estimated in 2004 that it would cost approximately $5.6 million to abate the LBP from the 95 contaminated buildings, which would include encapsulation or the removal of LBP, shipping the LBP chips off Midway, excavating contaminated sand and backfilling with clean sand, storing the contaminated soil in the old concrete lined R2 water tanks, and capping them with a synthetic liner (USFWS, 2004a).

In July 2004, the FWS attempted to mitigate LBP by placing shade cloth near buildings. Shade cloth was installed on the ground in a swath extending outward 3 meters around each building foundation with peeling LBP to prevent Albatross nesting from occurring in proximity to LBP flakes that could be ingested by chicks (USFWS, 2004b). The felt shade cloth degraded from rain and sunlight within 12 months and was found to be ineffective at preventing LBP poisoning in albatross chicks.

The FWS estimated that as many as 6,745 Laysan albatross chicks may be affected or die each year at Midway due to LBP The estimate was based on limited surveys of the buildings and the following assumptions: 1) average size of a building at Midway is 82 feet x 82 feet; 2) soil is contaminated extending outward from each building's foundation by 16 feet (Finkelstein et al., 2003); 3) all chicks within 16 feet of buildings ingest paint chips; and 4) average Laysan albatross nesting density around buildings is 1,180 nests/hectare (USFWS, 2004b).

2.4.6. Year 2005 Investigations

In the fall of 2005, FWS installed a woven plastic shade cloth extending outward 3 meters around 22 buildings known to have high levels of LBP. The FWS planned to use backpack vacuums to remove LBP chips (that fall off the buildings) from the cloth twice a year. The shade cloth seemed to slightly lower the number of chicks affected by LBP at the buildings where it was installed. However, high winds made it difficult to keep the shade cloth secured to the ground and caused the edges of the shade cloth to unravel, which entangled birds. The entanglements were

unacceptable and the shade cloth was replaced with a better material or secured by the summer of 2006. The shade cloth continued to be problematic and was removed by March 2007.

2.4.7. Year 2006 Investigations

In May 2006, Finkelstein estimated that as many as 10,000 Laysan albatross per year were potentially exposed to lethal levels of lead from the ingestion of LBP from deteriorating buildings and structures on the island (Finkelstein, Midway Update 2006). The number of chicks affected per year by lead-poisoning was estimated using three different measurements: 1) initial surveys of lead-poisoned chicks in 2001 (Finkelstein et al., 2003); 2) a survey of 41 buildings on Sand Island in May 2006 to estimate the number of chicks with nests close to buildings (Finkelstein, Midway Update 2006); and 3) an estimate of the number of chicks per hectare based on annual nest surveys and the proportion of the island habitat potentially affected by lead-based paint from buildings.

Finkelstein's estimate was slightly higher than the 2004 estimate of 6,745 chicks, but Finkelstein's estimate was derived from more intensive surveys and included chicks located within a distance of 15 meters of buildings. The report noted that the actual number of chicks affected by LBP will vary from year to year based on the number of Albatross that nest in a particular year (Finkelstein, 2006).

In October 2006, the BOSS management contractor, CII, began LBP remediation (removal of leaded paint). By January 2007, LBP had been removed from six buildings (Parachute Building, Electric Shop, Transportation Building, Carpentry Shop, Metal Shop, and Dry Storage). The Electric Shop, Transportation Building and Dry Storage were repainted with an environmentally friendly product.

2.4.8. Year 2007 Investigations

Refuge staff performed a survey of "droop-wing" Albatross chicks around a portion of the buildings containing LBP at the site during 2007. The objectives of this survey were to 1) determine the frequency of Laysan albatross chicks affected by LBP around buildings on Sand Island; and 2) determine if the frequency of droop wing albatross chicks has declined on Sand Island from 2006 to 2007 due to LBP remediation.

Laysan albatross chicks with severe "droop wing" were only observed around buildings with LBP. The frequency of droop wing chicks observed during a nearly identical survey on Sand Island in 2006 by Finkelstein (2006) was more than twice that of this 2007 survey (15 percent versus 6.1 percent). The apparent decline in the frequency of droop wing chick may have occurred because LBP was removed from 9 of the survey buildings (22 percent) between August 2006 and February 2007. However, the apparent decline may have been biased, because the 2007 survey occurred 4 weeks later in the year compared to the 2006 survey (June 21 through 23, 2007 verses May 19 through 23, 2006). There was a possibility that more droop wing chicks were actually present in 2007, but died before the survey took place (Klavitter, 2007).

2.4.9. Year 2009 Investigations

2.4.9.1. ECOLOGICAL RISK ASSESSMENT

The FWS completed an Ecological Risk Assessment (ERA) during 2009 for lead in soils of the site (USFWS, 2009). Mean lead concentrations from soil around buildings ranged from 30 mg/kg (Building 4210) to 1,183 mg/kg (Building 342, paint and oil storage). Table 1 summarizes the 2009 FWS lead in soil results.

Blood lead levels were reported for 103 Laysan albatross chicks that were located around buildings. The authors compared these blood levels to threshold levels of 10 micrograms per deciliter (µg/dL) and 50 µg/L, which were obtained from a summary paper by Franson (1996). These thresholds were reported in the Franson (1996) paper as 1 parts per million (ppm) wet weight and 50 ppm wet weight, respectively. The threshold of 1 ppm refers to "toxic" blood lead levels (based on clinical signs of toxicity), while 50 ppm is a blood lead level "compatible with death" in sensitive avian species. The blood lead levels selected by Franson (1996) are discussed further in Appendix C (Section 3.1.2).The FWS concluded:

- A review of the current activities indicates that ongoing deterioration of abandoned buildings and maintenance of existing buildings could continue to add lead contamination to Sand Island.
- Additional soil sampling will be necessary to map the boundaries (depth and distance) of contaminated areas. FWS recommended that an x-ray fluorescence instrument (XRF) be used to efficiently delineate contamination of soil around individual buildings scheduled to be remediated.
- Although elevated lead concentrations occurred primarily at shallow depths, it was observed at deeper depths in some locations. Some locations with little or no elevated surface concentrations had high subsurface concentrations.
- Laysan albatross chicks that are located within 5 meters of a building known to have lead contaminated soil at higher levels are at a higher risk of lead poisoning. These contaminated soils pose continued risk to chicks if left in place. Chicks 5 to 15 meters from the buildings also had elevated lead blood levels.
- During the site investigation, few visible paint chips on the ground were observed including in areas where birds had elevated blood lead levels. However, soil lead was elevated in areas where birds had elevated blood lead levels. Therefore, the conclusion is that elevated lead concentrations in soil (this study) or paint chips on the ground (other studies) can contribute to lead toxicity severe enough to cause Laysan albatross chick adverse effects.
- Bonin petrels burrow below ground, and there was evidence of soil cycling from below ground to above ground and vice versa.
- Blood lead levels of some Bonin petrel chicks were elevated around buildings with increased lead soil levels but not at reference sites. Additional study is required to determine (a) depth of burrows, (b) effects levels for lead in Bonin petrel chicks, (c) exposure of adult Bonin petrels, and (d) extent of movement of lead through the soil column due to petrel burrowing activity.
- Additional study is required on the lead pathway to determine if Laysan ducks are at risk.

2.4.9.1.1. POINTS OF CONCERN FOR 2009 ERA

Task 1 of GeoEngineers original scope of services included a preliminary review of the FWS' ERA. GeoEngineers provided a review of the ERA in a memorandum dated October 20, 2009, offering a variety of concerns about the sampling and data evaluation methodology that affect the protective cleanup values derived in the document.

- As part of GeoEngineers' evaluation, a number of the FWS soil samples were submitted to a laboratory for total lead analysis. The results of this testing are summarized in Table 2.
- The 2009 FWS ERA used threshold blood lead levels presented in the Franson (1996) paper. The 2009 FWS ERA referenced levels of 10 and 50 µg/dL appear to be off by a factor of 10. Using the unit conversion of 100 µg/dL = 1ppm (provided in Franson [1996]), these thresholds of 1 ppm and 50 ppm should have been 100 µg/dL and 500 µg/dL, respectively. The threshold levels of 100 µg/dL and 500 µg/dL have been used for this EE/CA.FWS also concluded that the background lead soil levels on Sand Island were 67 mg/kg. The FWS study did not consider outliers and calculated background concentrations of reference sites that appear to be contaminated with lead. As such, the calculated background level presented in the 2009 ERA is biased high.

2.4.9.2. 2009 PACIFIC SEABIRD GROUP MEETING

A scientific paper was published (Finkelstein et al., 2009), that describes how LBP has the potential for population level effects on the Laysan albatross population. This paper was presented at the annual Pacific Seabird Group Meeting in Hokadate, Japan. In summary, an assessment was made of the impacts on adult and chick mortality of Laysan albatross due to LBP at Midway. The authors quantified the relative effects of reducing adult mortality (from fisheries bycatch) and chick mortality (from ingestion of LBP) on population growth. It was demonstrated how management actions that protect or enhance juvenile survivorship can sometimes be effective at helping reverse population declines (Finkelstein et al., 2009).

In August 2009, soil samples were taken at 14 locations and analyzed for arsenic, chromium, lead and mercury. Five of those locations were further analyzed for seven analytes of polychlorinated biphenyl (PCB). Results indicated that there was only one soil sample location (Building 5309, abandoned Communication Building) that had significant contamination. These soils had elevated levels of lead, mercury and PCBs. Surface soil lead sample levels were only elevated near the Transportation Building (USFWS, 2009).

2.4.9.3. LBP ABATEMENT

Between February 2007 and October 2008, LBP was removed from or encapsulated on the following buildings: Paint Shop, Ski Warehouse, 4208, 4209, 4210, 4211, 414, 323 Sewer Building, and Charlie Barracks, bringing the total number of buildings remediated at this point to 15.

The FWS received American Recovery and Reinvestment Act (ARRA) funding to restore seven Buildings (Officer Quarters 417, 418, 419, 421, 422, 423 and 424), which included the total removal of all LBP from the interior and the encapsulation of all LBP on the exterior. Exterior LBP from homes 414, 415 and 416 was also encapsulated. In addition to the buildings above, exterior LBP from the Nuclear Test Ban Treaty building and the TV satellite building were encapsulated, bringing the total number of buildings remediated to 25.

3.0 GEOENGINEERS 2010 FIELD INVESTIGATION

This section describes the 2010 investigation completed by GeoEngineers in accordance with the Engineering Evaluation/Cost Analysis Work Plan dated June, 4, 2010. Appendix A presents a discussion of the field procedures used to collect samples. Laboratory analytical deliverables are presented on a compact disk in Appendix B. Appendix B also contains a quality assurance/quality control (QA/QC) evaluation for the field event and analytical data.

In general, soil samples were collected in the intervals between 0 to 6 inches, 12 to 18 inches and 24 to 30 inches below ground surface (bgs). The soil samples collected from the 0 to 6-inch interval were collected using composite sampling techniques. A five point composite sample was collected within a 10-foot radius of each exploration. The use of the composite sample provides better characterization of the lead in soil in the most exposed soil profile.

The 12 to 18 inch and the 24 to 30 inch samples were collected from discrete locations in each hand auger sample location.

Approximately 10 percent of the explorations were advanced to 36 inches bgs to verify the absence/presence of lead in deeper soils. The deeper soil samples were collected at 30 to 36 inches bgs. The samples were submitted for laboratory analysis of lead by EPA Method 6010.

One duplicate sample was collected and analyzed for every 20 primary samples.

Soil samples were collected at three sampling distances (0 to 15 feet, 15 to 30 feet and 30 to 45 feet from the building foundations) in a concentric pattern around each building. Soil samples were not collected at locations where concrete, large trees, roadways or other obstacles were present.

3.1. Soil Explorations

GeoEngineers completed the sampling effort between June 11, 2010 and June 16, 2010. In total, 694 samples were collected from 230 sample locations throughout the site. The samples were collected using a combination of hand tools including disposable plastic trowels, disposable gloves, stainless steel trowels and stainless steel hand augers.

3.1.1. Background Samples

Eighty-three background samples were collected from 20 background locations. The locations of the background samples are shown on Figures 2B, 2C, 2D and 2E. GeoEngineers collected samples at each background location from four intervals (0 to 6 inches, 12 to 18 inches, 24 to 30 inches and 30 to 36 inches). GeoEngineers attempted to place the background samples in locations on the Refuge that have not been historically developed.

3.1.2. Residential Samples

GeoEngineers selected five current or former residential structures for soil sampling. The residential structures were selected to cover a variety of construction types, styles and years. The soil around the following structures was sampled.

- Building 4203 (Bravo Barracks) – The Bravo barracks consists of three story structures that are still in use for residential housing. It is assumed that the concentrations of lead in soil around Building 4203 are similar to those around Building 4204 (Charlie Barracks).
- Building 421 (Historic Officers Quarters) – Building 421 is one of a number of single family residential structures that were used to house military officers. Building 421 has been used in the recent history for housing of on-site workers. It is assumed that the concentrations of lead in soil around Building 421 are similar to the other historical officer quarters (Buildings 414, 415, 416, 417, 418, 419, 422, 423 and 424).
- Building 4210 (Concrete Duplex) – Building 4210 is a concrete residential structure. It is assumed that the concentrations of lead in soil around Building 4210 are similar to the other concrete duplexes (Buildings 4208, 4209, 4211 and 4212).
- Building 578 (Marine Barracks) – Building 578 was historically used as residence for military personnel. It is assumed that the concentrations of lead in soil around Building 578 are similar to the other Marine Barracks, Building 579.

3.1.3. Operational and Historical Structure Samples

GeoEngineers selected seven non-residential structures for lead-in-soil sampling. The structures were selected to cover a variety of construction types, styles and years. The soil around the following structures was sampled.

- Building 623 (Cable House) – Building 623 is a historical cable house on the northern portion of the site. Building 623 is one of the oldest structures at the Refuge. It is assumed that the concentrations of lead in soil around Building 623 will be similar to those in the other Cable Buildings (Buildings 619, 626, 628 and 643).
- Building 5303 (R-2 Unit) – Building 5203 is the former R-2 unit used for storage of drinking water at the Refuge. R-2 is a concrete structure with exterior paint.
- Building 2403 (Furniture Warehouse Building) – Building 2403 is located near the Midway Mall Complex. The building is currently used for storage.
- Building 3512 (Gymnasium Building) – Building 3512 is located in the central portion of the Refuge. The building was historically used as a gymnasium.
- Building 363 (Recycling Storage Building) – Building 363 was historically used as a parachute and torpedo prepping area. The building is currently used for the storage of recycling materials such as glass, paper and plastic.
- Building 1124 (Harbor Shop and Office) – Building 1124 is located on the northeastern side of the inner harbor. The building is not currently used.

3.1.4. Opportunistic Samples

GeoEngineers collected a total of 16 opportunistic samples at various locations on the island. The following is a summary of the opportunistic samples.

- Opportunistic-01 and -02 were collected on the southern side of the bowling alley (Building 259).

- Opportunistic-03 and -04 were collected on the northern side of the Seaplane Hangar (Building 151).
- Opportunistic-05 and -06 were collected near Building 1123.
- Opportunistic-07 and -08 were collected near the JP-5 pump station at the former fuel farm.
- Opportunistic-09 was collected on the south side of the SKI warehouse (Building 393).
- Opportunistic -10 was collected on the western side of the Power Plant (Building 354).
- Opportunistic-11 and -12 were collected near Building 418.
- Opportunistic -13, -14, -15 and -16 were collected near the Marine Barracks (Buildings 578 and 579).

3.1.5. X-Ray Florescence Testing

GeoEngineers submitted 96 soil samples for laboratory analysis of lead content using an XRF. The purpose of submitting samples for XRF testing was to compare the XRF data to the sample analytical data generated by EPA Method 6010 to evaluate whether XRF data are adequate for guiding future response activities. Soil samples with a range of lead concentrations were submitted for testing by XRF methods.

The laboratory XRF testing was conducted in a manner similar to in-situ testing. That is, the laboratory performed XRF analyses without any preparatory steps (for example, drying, sieving and grinding). The analytical methodology was intended to obtain data that are similar to data that may be collected in the future removal action.

3.2. Results

The following sections summarize the chemical analytical data collected during the 2010 field investigation.

3.2.1. Lead Results

Lead was detected in 455 of the 696 samples submitted for chemical analysis. Detected concentrations ranged from 0.91 mg/kg to 9,300 mg/kg. In general, the highest lead concentrations were detected in the 0 to 6 inch and 12 to 18 inch depth profile. A discussion of the extent of contamination is included in Section 4.0. Table 3 summarizes the 2010 sampling results.

Lead concentrations from samples identified as background ranged from non-detect to 930 mg/kg. GeoEngineers evaluated the background lead data set using the EPA statistical software package ProUCL Version 4.00.04. ProUCL was used to identify potential outliers and to estimate background lead concentrations at the Site. Multiple lines of evidence were considered when evaluating potential outlier concentrations, including: 1) Dixon and Rosner tests for outlier identification; 2) visual examination of box-whisker plots and Q-Q plots; 3) comparison of potential outlier concentrations relative to the mean lead concentration from the 84 background samples; and 4) identification of spatial clusters of potential outliers. Based on these lines of evidence, GeoEngineers identified the analytical results associated with soil samples obtained at background locations 15 and 16 as outliers. Background sample locations 15 and 16 may be from an area that was developed in the past.

ProUCL calculates background concentrations (95th percentile Upper Prediction Limits [UPL95]) two ways: 1) setting non-detect results at their reporting limit; and 2) using the Kaplan-Meier statistic to evaluate the multiple reporting limits associated with the background lead data set. Using the full background lead data (outliers retained), the UPL95 estimated using these two methods are 118 mg/kg and 203 mg/kg. These values are well above any reasonable estimate of background lead levels. After removing the sample results associated with background locations 15 and 16, the UPL95 estimated using these two methods are 5.7 mg/kg and 9.4 mg/kg.

3.2.2. Toxicity Characteristic Leaching Procedure Results

The five soil samples with the highest concentration of total lead were submitted for leachable concentrations of lead using toxicity characteristic leaching procedure (TCLP) methods. The results of the TCLP ranged from less than the method reporting limit (MRL) to 0.48 milligrams per liter (mg/l). The soil is therefore considered non-hazardous as all the results were below the 5.0 mg/l regulatory limit for D008 wastes (wastes containing lead).

3.2.3. XRF Results

A comparison of the XRF results to total lead results is summarized in Table 5. In general, the correlation between the two testing methods was outside of the desired relative percent difference (RPD) of 20 percent. Based on the "in-situ" testing (no drying, sieving, grounding, etc) the use of an XRF in this fashion to drive the field investigation is not acceptable. The removal action will either require the use of an XRF with the proper preparatory work, per EPA Method 6200, or a mobile laboratory.

4.0 SOURCE, NATURE AND EXTENT OF CONTAMINATION

This section summarizes the nature and extent of lead contamination at the Refuge based on the results of investigations summarized in the previous sections of this EE/CA. As previously discussed, the focus of this EE/CA was on the lead on buildings and lead in soil. No other contaminants of concern (COC) were evaluated. Other contaminants such as mercury and PCBs have been detected in site soils, but these contaminants were not evaluated during this action. Future actions will potentially include an evaluation into risks associated with other COC. For disposal and worker safety purposes, asbestos is a contaminant that is addressed. The lead on the buildings is considered a COC because of the potential for the LBP chips continuing to peel and flake off the buildings and re-contaminating site soils.

The results from 2009 ERA investigation by the FWS and the 2010 field investigation by GeoEngineers were used to evaluate the nature and extent of lead in soil. Tables 1 and 3 list the samples used for the evaluation of lead contamination in soil and the attached figures show the location of these samples.

The analytical results for surface and subsurface soil were compared to the derived site cleanup value of 75 mg/kg to assist in the discussion of the nature and extent of lead in soil. This value (75 mg/kg) is also referred to as the preliminary cleanup goal (PCG). Concentrations of lead greater than 75 mg/kg are referred to as "elevated concentrations" in this EE/CA. Please refer to Section 5 of the EE/CA for a discussion on the derivation of the PCG.

Surface and subsurface soil samples have been collected from hundreds of locations throughout the site and analyzed for lead. The sample locations are spread throughout the site and represent both residential and non-residential structures. To facilitate the evaluation of risk (see Section 5.0), the site was divided into nine areas (Decision Units 1 through 9).

With a few exceptions, soil samples collected from the site contained elevated concentrations of lead. Elevated concentrations of lead appear to be widespread in surface soils in all Decision Units, with a number of areas having elevated concentrations of lead in deeper soils. The concentration of lead in soil by Decision Unit is discussed below.

4.1. Decision Unit 1

Decision Unit 1 includes Buildings 619, 623, 626, 628 and 643 (Cable Buildings) and the soils surrounding the Cable Buildings. Elevated concentrations of lead were noted in almost all 0 to 6 inch depth interval samples around Building 623. In addition, most sample locations showed elevated lead concentrations at depth. Based on the sampling results, the area of lead contaminated soil extends out at least 45 to 50 feet from the perimeter of each structure and extends down to depths as great as 36 inches bgs.

The analytical data for soil surrounding Building 623 are given in Table 3 and shown on Figure 3. The analytical data for soil surrounding Building 643 are given in Table 1 and the sample locations are shown on Figure 4.

Buildings 623 and 643 are historic Cable Buildings on the northern portion of the site. It is assumed that the concentrations of lead in soil around Buildings 623 and 643 will be similar to those in the other Cable Buildings (Buildings 619, 626 and 628).

4.2. Decision Unit 2

Decision Unit 2 includes Buildings 578 and 579 (Marine Barracks) and the soils surrounding the buildings. GeoEngineers collected four opportunistic samples (Opportunistic 13 through 16) from the soils surrounding Buildings 578 and 579. Concentrations of lead in the 0 to 6 inch soil samples ranged from 370 mg/kg to 920 mg/kg.

The results from the 2009 FWS testing near Building 578 (samples 311 through 332 and 3181) indicated XRF lead concentrations in excess of 71 mg/kg. The contamination was noted in soils at a distance as great as 20 feet from Building 578 with detection in samples as deep as 12 inches bgs. Based on the sampling results, the area of lead contaminated soil extends out approximately 15 feet out from the building and depths greater than 12-inches bgs.

The analytical data for soil surrounding Building 578 are given in Tables 1 and 3 and shown on Figures 2C and 5. The analytical data for soil surrounding Building 579 is given in Table 3 and the sample locations are shown on Figures 2C.

4.3. Decision Unit 3

Decision Unit 3 includes the exterior paint on Building 4203 (BOQ Bravo Barracks) and Building 4212, and the lead contaminated soil in the vicinity of Buildings 4203, 4204, the Officers

Quarters buildings 415, 416, 417, 418, 419, 421, 422, 423 and 424, residential duplexes including buildings 4209, 4210, 4211 and 414.

The results from GeoEngineers 2010 sampling around Building 4203 showed limited contamination, primarily on the southern end of the Barracks at depths as great as 36 inches bgs. The FWS sampling in 2009 around Building 4203 showed no lead concentrations above the PCG. Based on these results, the contaminated soils around the two Barracks (Buildings 4203 and 4204) appears to be limited and the distribution is not uniform. The analytical data for soil surrounding Building 4203 are given in Tables 1 and 3 and the sample locations are shown on Figures 6 and 7.

Lead was detected in only two GeoEngineers samples from around Building 4210 (residential structure) at concentrations above the PCG of 75 mg/kg and the 2009 FWS sampling indicated no detections of lead at concentrations above the PCG. The soils around Building 4210, and possibly the other residential duplexes, generally do not contain concentrations of lead in soil greater than the PCG based on these results. The analytical data for soil surrounding Building 4210 are given in Tables 1 and 3 and the sample locations are shown on Figure 8.

GeoEngineers' 2010 sampling around Building 421 (officer quarters) showed limited areas of elevated lead concentrations, with detections above the PCG primarily found in the upper six inches of soil. The analytical data for soil surrounding Building 421 are given in Table 3 and the sample locations are shown on Figure 9.

Opportunistic samples 11 and 12 were collected near Building 418 (officer quarters), both showed elevated lead concentrations. The analytical data for soil surrounding Building 421 are given in Table 3 and the sample locations are shown on Figure 2B.

The FWS sampled around Buildings 414 and 416. A number of the XRF samples had lead detections above the PCG. The detected lead was found within 15 feet of the building perimeter. Based on the 2009 sampling, the general area of contamination was found within 15 feet of a structure with the contamination most notably found in the upper 12 inches of soil. Based on the sampling results, the area of lead contaminated soil extends out approximately 15 feet out from the building and to depths greater than 12 inches bgs. The analytical data for soil surrounding Buildings 414 and 416 are given in Table 1 and the sample locations are shown on Figure 10.

4.4. Decision Unit 4

Decision Unit 4 includes the Midway Mall (Building 259), Building 2403, Building 2404 and the contaminated soils around these buildings. The results of GeoEngineers 2010 sampling around Building 2403 detected lead at concentrations above the PCG in a number of surface and subsurface soil samples. Elevated lead concentrations were found on all sides of the building with contamination extending down as deep as 36-inches bgs. The analytical data for soil surrounding Building 2403 are given in Table 3 and the sample locations are shown on Figure 11.

The results from the 2009 FWS testing near Building 259 indicated XRF lead concentrations in excess of the PCG. The contamination was noted in soils located as great as 26 feet from the

building with detection in samples as deep as 12 inches bgs. The analytical data for soil surrounding Building 259 are given in Table 1 and the sample locations are shown on Figure 12.

Based on the sampling results, the area of lead contaminated soil extends out between 15 and 20 feet out from the buildings in this Decision Unit and the contamination extends to depths up to 36 inches bgs.

4.5. Decision Unit 5

Decision Unit 5 includes Building 5309 (the former Transmitter building) and 5303 (R2 Unit) and the contaminated soils around these structures. GeoEngineers sampling results for soil around Building 5303 (R2 Unit) indicated sporadic detection of lead above the PCG. In general, elevated detections were noted in the 0 to 6 inch sample with limited deeper detections. Most detections were found within 15 feet of the structure. The analytical data for soil surrounding Building 5303 are given in Table 3 and the sample locations are shown on Figure 13.

The FWS collected soil samples from around Building 5309 in 2009. The XRF results indicated limited lead contamination, primarily in depths less than 12 inches bgs. The distribution was sporadic, with detections ranging out to 25 feet from the building foundation. The analytical data for soil surrounding Building 5309 are given in Table 1 and the sample locations are shown on Figure 14.

4.6. Decision Unit 6

Decision Unit 6 includes Buildings 393 (SKI warehouse), 356 (Transportation shop), 357 (Machine shop), 353 (Carpenter shop), 349 (Cold storage), 342 (hazardous materials storage), 363 (Torpedo shop/recycling) and 151 (Seaplane Hangar) and the contaminated soils around these structures. GeoEngineers sampling results for soil around Building 363 indicate the presence of lead contaminated soil above the PCG in almost all of the 0 to 6 inch samples. Additionally, the majority of the deeper samples (up to 36 inches bgs) contained elevated lead concentrations. GeoEngineers also collected four opportunistic samples around structures in Decision Unit 6. All but one sample, contained concentrations of lead above 75 mg/kg. The analytical data for soil surrounding Building 363 are given in Table 3 and the sample locations are shown on Figures 2C and 15.

The FWS XRF data indicated that almost all samples collected around Buildings 342, 353 and 357 contained lead concentrations above the PCG. The FWS data indicated that lead concentrations were in excess of 75 mg/kg in most of the deeper samples (12 inches bgs). The analytical data for soil surrounding Buildings 342, 353 and 357 are given in Table 1 and the sample locations are shown on Figure 16.

4.7. Decision Unit 7

Decision Unit 7 includes Buildings 331 (Medical Clinic/Offices), 3502 (Galley), 3503 (Barracks C), 3504 (Barracks D), 3512 (Gymnasium) and the contaminated soils around these structures. GeoEngineers sampling results for soil around Building 3504 indicated that elevated lead in soil concentrations were primarily noted on the southern and eastern sides of the abandoned barracks. Both surface and subsurface soils had lead levels above the PCG. The analytical data for soil surrounding Building 3504 are given in Table 3 and the sample locations are shown on Figure 17.

GeoEngineers also sampled around Building 3512. Elevated lead was found in a limited number of samples, primarily from the east and south sides of the structure. Contaminated soils were found in both surface and subsurface samples, with detections above the PCG in samples as deep as 28 inches bgs. The analytical data for soil surrounding Building 3512 are given in Table 3 and the sample locations are shown on Figure 18.

4.8. Decision Unit 8

Decision Unit 8 includes the fuel storage tanks at the old fuel farm and the contaminated soils around the aboveground storage tanks (ASTs). Neither GeoEngineers nor the FWS has collected soil samples from the areas around ASTs. We have assumed that surface soils located within the lined containment berm area are contaminated with lead.

4.9. Decision Unit 9

Decision Unit 9 includes the remaining structures that are in use at the Refuge (except for the above ground water tanks near the airport that will be painted with lead-encapsulating paint) and the remaining contaminated soils. This Decision Unit is broad based and includes the remaining buildings, storage buildings, pump houses, lift stations and other ancillary structures. There are at least 44 buildings and a number of ancillary structures (memorials, lift stations, electrical substations, flag poles, hydrants, etc) that have been painted with LBP and most likely have contaminated soil in the vicinity of each structure.

GeoEngineers collected an opportunistic sample (Opportunistic 10) on the western side of Building 354 (Power Plant). Lead was detected at concentrations above the PCG of 75 mg/kg. GeoEngineers also collected two opportunistic samples around Building 421 (JP-5 pump house). Lead was detected in the 0 to 6 inch sample for Opportunistic samples 07 and 08 at concentrations above the PCG in both samples. The analytical data for soil surrounding Opportunistic samples 07, 08 and 10 are given in Table 3 and the sample locations are shown on Figures 2C and 2D.

GeoEngineers also collected samples around Building 1124 (Harbor Building). Only one sample contained lead concentrations above the PCG. A number of samples showed lead concentrations ranging from 25 mg/kg to 65 mg/kg, but the results were below the PCG of 75mg/kg. The analytical data for soil surrounding Building 1124 are given in Table 3 and the sample locations are shown on Figure 19.

5.0 STREAMLINED RISK EVALUATION

The potential risk to the avian receptors at Sand Island from exposure to LBP and lead contaminated soil were evaluated using a line-of-evidence (LOE) approach. Studies at Sand Island have shown that ingesting LBP chips from buildings and LBP chips in the soil have caused mortality and other visible effects of lead poisoning in seabirds, including droop wing. The primary receptors that have shown these effects are Laysan Albatross chicks (USFWS, 2009; Finkelstein et al., 2003; Sileo et al., 1990; Sileo and Fefer, 1987). The focus of the SRE is to evaluate avian exposure to lead.

Desk-top risk based concentrations (RBC) modeling (i.e. standard ERA exposure modeling) and establishment of a correlation between avian blood lead and soil lead correlations using the scientific literature are presented as the two primary LOE for recommending a cleanup level. The goal of the SRE is to recommend a cleanup level for lead in soil that is representative of both LOE and protective of avian receptors at the Refuge including Laysan Albatross and Bonin Petrel.

A lead cleanup value of 75 mg/kg was established using the avian blood lead/dietary lead correlation. This cleanup level is based on the assumption that blood lead levels in the range of 20 to 150 µg/dL from Franson (1996) (as cited in USFWS 2009) are indicative of subclinical toxicity above which adverse effects may occur to avian receptors at Sand Island including the Bonin petrel, Laysan albatross and Laysan duck. (See Appendix C, Section 3.1.2 for additional discussion of the blood lead levels cited in the 1996 Franson report). The FWS (2009) ERA used a threshold of 100 µg/dL (from Franson 1996 and incorrectly reported as 10 µg/dL in FWS 2009), based on the occurrence of clinical signs of toxicity. The threshold of 20 µg/dL based on subclinical toxicity was used in this SRE because it is more protective than the threshold based on clinical signs of toxicity. Eisler (1988) identified avian blood lead levels greater than 20 µg/dL as being "elevated."

Adopting this range as an approximate threshold for adverse effects in avian receptors and using the modeled lead risk based concentration (RBC) for Bonin petrel as well as evidence from our blood-soil lead regression analysis indicate that a soil lead cleanup level of 75 mg/kg would be an appropriate value to protect individual avian receptors at Sand Island. Appendix C contains the full risk evaluation.

Justification for a cleanup value of 75 mg/kg is as follows:

- Using the linear regression we developed, the cleanup value of 75 mg/kg equates to a blood lead level of 20 µg/dL, which falls at the low end of the 20 to 100 µg/dL range reported by Franson (1996) as being protective of various species of falconiforme, columbiforme and galliforme bird species.
- The Bonin petrel RBC that we calculated was based on a no observed adverse effect level (NOAEL) toxicity reference values (TRV) of 106 mg/kg and represents the protection of avian species at the individual level, which is consistent with EPA CERCLA guidance for ecological risk assessment. The recommended cleanup level of 75 mg/kg is less than the NOAEL based Bonin petrel RBC of 106 mg/kg.
- Evidence from Franson (1996) and others suggests that tissue lead residues including blood, kidney and liver that are associated with chronic lead poisoning in avian receptors can generate adverse effects in these species well before the onset of physiological injury and death. Therefore, a cleanup value that is based on the low end of the subclinical range of toxicity should be protective of birds prior to additional exposures that may be lethally toxic.

6.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

Based on the "Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA" (EPA, August 1993) and information required by the NCP (40 CFR 300.430[e]), an EE/CA consists of three phases:

- Developing removal action alternatives;
- Screening the alternatives; and
- Conducting a detailed analysis of the potential alternatives.

The following steps were used in developing the removal action alternatives:

1. Identify ARARs
2. Develop RAOs
3. Identify PCGs using chemical-specific ARARs and human health and environmental risk-based levels, including levels necessary to protect wildlife species
4. Develop general response actions
5. Identify and screen technologies and process options (including innovative technologies)
6. Assemble remaining technologies and process options into removal action alternatives

6.1. Statutory Limits on Removal Actions

6.2. Statutory limits on Removal Actions are Defined under Section 104(c)(1) of CERCLA. Determination of Removal Scope

RAOs are site-specific goals for protecting human health and the environment established on the basis of the nature and extent of the contamination, resources that are currently and potentially threatened, and the potential for human and environmental exposure. The RAOs specify the contaminants of concern (COCs), potential exposure routes and receptors, and acceptable contaminant concentrations (or range of acceptable contaminant concentrations for each exposure route).

Based on current site data and evaluations of potential risk, lead was identified as being a COC and the primary cause of ecological risk at the site is through direct ingestion. Therefore, the RAOs for the site include the following:

- Prevent potential exposure of birds to contaminated soil that would create blood levels above 20 µg/dL, which is at the low end of the 20 to 100 µg/dL range reported by Franson (1996) as being protective of various species of falconiforme, columbiforme and galliforme bird species.
- The ERA in Appendix C provides a detailed discussion on the blood levels.

A specific RAO has not been provided for lead on structures. The removal or encapsulation of lead on the structures will be one of the removal action alternatives evaluated.

6.3. Determination of Removal Schedule

The time-frame for the initiation of removal actions is dependent upon the availability of funds, seasonal limitations on work dictated by the presence of birds at Midway, available space to house response staff and FWS coordination with regulatory agencies, such as NOAA on endangered species impacts and with other divisions of the FWS for addressing the Endangered Species Act (ESA) and the Migratory Bird Treaty Act (MBTA). Due to the uncertainty in project funding, presentation of a definitive schedule for the implementation of the removal alternatives is impractical at this point.

6.4. Summary of ARARs

Applicable, relevant, and appropriate requirements were considered in developing this EE/CA. Applicable requirements are those standards, requirements, criteria, or limitations promulgated under federal, state, or local law that specifically address a hazardous substance, pollutant, contaminant, response action, location, or other circumstance at a CERCLA site. Relevant and appropriate requirements are those standards, requirements, criteria, or limitations promulgated under federal, state, or local law that address problems or situations similar to those encountered at the CERCLA site, and therefore, are suited for that site. Although not legally applicable, these requirements may be relevant and appropriate for a particular CERCLA site. There is no state ARARs associated with the removal actions considered for this project.

ARARs fall into three categories:

- Chemical-specific ARARs are health-based or risk-management-based criteria that provide concentration limits for the occurrence of a chemical in the environment.
- Location-specific ARARs restrict actions or discharges in certain cultural, agricultural, or ecologically sensitive environments.
- Action-specific ARARs are activity-based or technology-based, and typically control response activities that perform specific actions, such as generating wastes.

ARARs may be applicable; relevant and appropriate; or to be considered (TBC) criteria. Applicable standards include standards of control and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal environmental or facility citing laws that specifically address a hazardous substance, pollutant or contaminant, response action, location or other circumstances at a CERCLA site.

Relevant and appropriate requirements are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal law that are well suited to the particular site. While not necessarily “applicable” to the specific site circumstances, relevant and appropriate requirements address problems or situations similar to those encountered at the site to justify their use.

A requirement must first be determined to be relevant, then appropriate. In general, this involves a comparison of a number of site-specific factors, including the characteristics of the removal action, the nature of the hazardous substance present at the site and applicable regulatory requirements.

TBC criteria are non-promulgated advisories or guidance issued by federal government that are not legally binding and do not have the status of potential ARARs. However, in many circumstances TBCs will be considered along with ARARs. For example, the EPA Regional Screening Levels (RSLs) (EPA, April 2009) are considered TBCs for specific contaminants.

6.4.1. Chemical-Specific ARARs

Chemical-specific ARARs address management of specific chemicals, including the release to the environment of materials possessing certain chemical or physical characteristics or containing specific chemical compounds. Lead is the COC for soil at the site. There are no chemical-specific ARARs for the COCs in soil. The TBC criteria for the COCs in soil are provided in Table 6.

6.4.2. Location-Specific ARARs

Location-specific ARARs restrict activities in certain sensitive environments, such as wetlands and flood plains. The potential location-specific ARARs and TBC criteria for the removal action alternatives evaluated are provided in Table 7.

Proposed work in Decision Units 1 and 2 may include the removal of historical buildings. This action will be considered an adverse effect. The FWS will work with the Hawaiian State Historic Preservation Department (SHPD) and Advisory Council to modify the memorandum of agreement (MOA) between the FWS and SHPD. The FWS will attempt to modify the MOA to allow for the complete demolition and removal of the Cable Buildings and the concrete foundations of the buildings. If an agreement cannot be made, the decommissioning of the Cable Buildings may be done via dismantling and the concrete foundations may remain in place. Additional details regarding the potential MOA requirements are discussed in Section 8.1.

6.4.3. Action-Specific ARARs

Action-specific ARARs are activity-based or technology-based requirements, and typically affect performance, design, or other similar action-specific controls or restrictions on certain activities related to remediation. The potential action-specific ARARs for the removal action alternatives evaluated are summarized in Table 8.

6.5. Preliminary Cleanup Goals

For purposes of evaluating removal action alternatives, the RAOs associated with risks posed by the contaminant of concern (lead) in site soils were converted into a contaminant-specific concentration. The contaminant-specific concentration is referred to as the PCG, and was developed by considering collectively the ARARs and TBCs (described in Section 6.4). The PCG provides a basis for defining the general areas and associated volumes of contaminated media. The PCG should not be considered as the final cleanup goal; the final cleanup goal will be identified in the decision document for the site (that is, the Action Memorandum).

The PCG for lead for avian species is 75 mg/kg. This value is also protective of future residents (based on EPA's 400 mg/kg screening level). The future residence PCG was chosen using values derived from the EPA's Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK; EPA, 2004) and EPA's generic lead in soil concentrations.

6.6. Removal Action Area

The removal action area (RAA) consists of portions of the site where lead is present at concentrations exceeding natural background concentrations and one or more human or ecological risk screening criteria. As noted in Sections 3 and 4, lead in soil is the primary COC at the site and the focus of this EE/CA.

The RAA for each Decision Unit covers the extent of contamination as discussed in Section 4.0. The RAA includes the abatement of the exterior lead on site structures and site soils around structures that contain lead at concentrations above the PCG of 75 mg/kg. The extent of soil contamination for each Decision Unit is subject to modification based on additional data. The extent of the soil contamination can only be estimated at this time because of the distribution of lead, the number of buildings and the lack of soil sampling around every structure.

The FWS has conducted the removal of LBP and ACM from a number of existing structures. The removed material is currently being stored at the airport Hangar. All removal alternatives presented in this EE/CA include costs for the removal and disposal of the existing hazardous building materials. The FWS is considering the disposal of the existing hazardous building materials (listed below) during a time-critical action removal. Material includes:

- Loose building material has been placed in the 58x24 foot "weight room" at the Hangar. The room has been lined with plastic.
- Loose building material debris is also being stored in 72 4 foot by 4 foot by 4 foot totes.
- LBP debris is stored in approximately 56 drums. The drums consist of both 55-gallon drums and 85-gallon drums.

Four 20-foot connex containers are being used to store material. Connex-1 is half full of double bagged ACM, connex-2 has 21 drums of ACM, connex-3 contains 14 drums of ACM and 50 double bagged ACM and connex-4 contains 34 drums of LBP.

An evaluation was performed to identify the areas that, if removed, would result in an acceptable residual risk within a given Decision Unit. The following conclusions were drawn for the lead in soil determination:

- For Decision Unit 1, elevated concentrations of lead in soil were detected throughout the area. Approximately 3,500 cubic yards of soil per vertical foot of depth exists at concentrations greater than the PCG assuming that lead contamination extends outward a distance of 50 feet from each building. If the entire area was excavated to a depth of 3 feet bgs, the removal action would generate approximately 10,400 cubic yards of lead contaminated soil. The estimated volume of building demolition debris (Cable Buildings 619, 623, 626, 628) is approximately 2,500 cubic yards. The removal of the historic Cable Buildings is considered an adverse effect. The FWS will consult with the SHPD and the Advisory Council. The FWS will attempt to modify the MOA to allow for the complete demolition and removal of the Cable Buildings and the concrete foundations of the buildings. If an agreement cannot be made, the decommissioning of the Cable Buildings may be done via dismantling and the concrete foundations will need to remain in place.

- Decision Unit 2 soils contained elevated lead concentrations near the two barracks. GeoEngineers collected four opportunistic samples from the soils surrounding Buildings 578 and 579. Concentrations of lead in the 0 to 6 inch soil samples ranged from 370 mg/kg to 920 mg/kg. The results from the 2009 FWS testing indicated XRF lead concentrations in excess of 75 mg/kg. If the entire Decision Unit was excavated to a depth of 2 feet bgs, approximately 1,400 cubic yards of lead contaminated soil would be removed. The estimated volume of building demolition debris is approximately 3,000 cubic yards. Similar to Decision Unit 1, the demolition of the barracks is considered an adverse effect under the existing MOA. The FWS will consult with the SHPD and Advisory Council on modifying the MOA.
- For Decision Unit 3, lead contaminated soil was found at concentrations above the PCG within 15 feet of a structure with the contamination most notably found in the upper 12 inches of soil. Very limited soil contamination was found around Building 4210 (concrete duplex). Based on the sampling results, the area of lead contaminated soil at concentrations above the PCG extends out approximately 15 feet out from buildings to depths greater than 12 inches bgs. About 2,000 cubic yards of lead contaminated soil at concentrations above the PCG would be generated if an area 15 feet out from most structures (except for 4210), was excavated to a depth of 12 inches bgs. This assumes that the other duplexes have very limited lead in soil contamination.
- For Decision Unit 4, elevated lead concentrations were found in soil on all sides of the buildings with contamination extending down as deep as 36 inches bgs. Based on the sampling results, the area of lead contaminated soil at concentrations above the PCG extends out between 15 and 20 feet from the building and to depths as deep as 36 inches bgs. If soil was removed the area from 15 feet out from each building to a depth of 3 feet bgs, the volume of soil generated would be approximately 3,200 cubic yards. A number of the buildings in the Decision Unit have walkways, pathway and concrete pads or patios. We have assumed that the actual volume that poses a risk (due to these obstructions) is approximately 2,000 cubic yards.
- For Decision Unit 5, sampling indicated sporadic detections of lead above the PCG. In general, elevated detections were noted in the 0 to 6 sample with limited deeper detections. Most detections were found within 15 feet of the structures. We have assumed that the soils from 0 to 15 feet from each structure to a depth of 1 foot will be addressed. If this area is excavated, the volume of soil generated is approximately 1,000 cubic yards.
- For Decision Unit 6, sampling indicated wide spread contamination. Elevated concentrations of lead were found in soil in both shallow and deep samples with the contamination extending at least 45 feet from building foundations and to depths as great as 36 inches bgs. Most of these buildings have some level of development (roadways, concrete, and walkways) around them that will make excavation difficult. In certain areas, the concrete pads and walkways will need to be swept clean. Roadbeds (crushed rock or concrete) will not be removed. Based on conservative estimates, the volume of soil with lead at concentrations greater than the PCG in Decision Unit 6 is approximately 14,000 cubic yards.
- For Decision Unit 7, sampling indicated a non uniform distribution of lead in soil. Due to the sporadic detections, determining the extent of the soil contamination is difficult. GeoEngineers has assumed that about 30 percent of soils around each building to a distance of 30 feet from the building footprint are contaminated with lead at concentrations greater than the PCG to a

depth of 2.5 feet bgs. It is likely that additional sampling (including the use of a field XRF unit) may determine that the volume of soil is less than estimated. A conservative estimate of the volume of soil in Decision Unit 7 with lead at concentrations exceeding the PCG is approximately 3,000 cubic yards.

- For Decision Unit 8, we have assumed that all soils located within the lined containment berm area are contaminated with lead. We have assumed that a 6 inch layer of sand is present in the lined berm area. A conservative estimate of the volume of soil in Decision Unit 8 that may contain lead at concentrations exceeding the PCG is approximately 800 cubic yards.
- Decision Unit 9 includes the remaining structures that are in use at Midway and the remaining contaminated soils. This Decision Unit is broad based and includes the remaining buildings, storage buildings, pump houses, lift stations and other ancillary structures. There are at least 44 buildings and a number of ancillary structures (memorials, lift stations, electrical substations, flag poles, hydrants, etc) that have been painted with lead based paint and most likely have lead contaminated soil in the vicinity of each structure. This Decision Unit includes Building 5306 (Airport Building) which is the single largest structure on the island. It is difficult to define the removal action area because of the number of structures, the various sizes and state of disrepair on these structures. GeoEngineers has relied on a number of planning level estimates prepared by the FWS to estimate the square footage of lead based paint that will need to be removed from this Decision Unit. We have made a conservative estimate that as much as 12,000 cubic yards of soil may contain lead at concentrations exceeding the PCG.

7.0 IDENTIFICATION AND SCREENING OF RESPONSE ACTION ALTERNATIVES

General response actions are media-specific actions that satisfy the RAOs. The following general removal actions were identified as consistent with the project objectives and goals:

- No Action
- Land use controls (LUCs)
- Containment
- Excavation
- Waste Disposal

Except for the No Action removal action, each general removal action can be implemented by a variety of technologies and process options. Removal technologies are the general categories of remedies under a general removal action, while process options are specific categories of remedies within each response technology.

7.1. Screening of Alternatives

The following section outlines an array of potential alternatives for the remediation of lead in soil at the Refuge. The purpose of listing the various alternatives is to allow for an immediate screening of those options which are obviously irrelevant and thereby eliminate the need for an additional screening step in the overall removal alternative evaluation process. This section will evaluate the potential alternatives for effectiveness, implementability and cost.

Following the qualitative screening, only the technologies and process options considered most feasible for achieving the RAOs for the contaminated soils were carried forward, assembled into removal action alternatives, and subjected to the detailed and comparative analysis described in Sections 8.0 and 9.0.

The technologies and process options considered for remediation of lead contaminated soil were screened using the three qualitative criteria identified below and described in the following subsections.

7.1.1. Effectiveness

Effectiveness pertains to the ability to meet the objectives and relative permanence within the scope of the removal action. The effectiveness criteria also considers the time-frame of the removal action.

7.1.2. Implementability

Implementability refers to the ease or difficulty of implementing the removal action, considering technical, mechanical and regulatory requirements.

7.1.3. Cost

The cost criteria considers both the capital and the operation and maintenance (O&M) costs of the proposed technology, compares costs between technologies, and compares the cost of the technology to the resulting benefits. During the screening process, detailed, site-specific cost estimates were not developed, they will be provided during the detailed analysis of removal action alternatives.

The relative cost was considered only if the cost of a technology was believed to be significantly higher than the cost of the other technologies that are comparably effective or implementable. Therefore, the emphasis was placed on the overall effectiveness and implementability while comparing the potential response technologies and process options.

7.2. No Action

The No Action alternative serves as a baseline for comparison with other response technologies and process options, as required by the National Oil and Hazardous Substances Contingency Plan (NCP). The No Action alternative requires that no removal or response actions would be taken to meet the RAOs. The No Action alternative will be retained for comparison purposes.

7.3. Land Use Controls

Land use controls (LUCs) are legal, administrative, or physical constraints that restrict or control access to property to protect the integrity of engineering remedies and to limit exposure to contaminated media. Control measures that are social in nature can be as effective as response technologies in preventing exposure to lead contaminated soil. The primary purpose of these controls is to minimize development and human/ecological activities in impacted areas and also to provide protection to an implemented solution. The use of LUCs does not, in itself, achieve RAOs but does protect those remedies that are implemented on-site.

LUCs do not change the magnitude of contamination present in the soil, but they can be effective in preventing exposure to contamination at a site. The effectiveness of the LUCs depends on successful implementation and long-term maintenance. Appropriate mechanisms to manage LUCs would need to be incorporated into the existing land use management processes.

LUCs could be easily implemented and there is minimal capital cost associated with this alternative. The long term O&M costs would depend on the duration of monitoring program and other regulatory requirements. Monitoring costs would be relatively low in comparison with removal or response system performance monitoring.

The LUC process options retained for the site include land use restrictions and site controls. LUCs would also be effective at limiting potential exposure to lead contaminated soil at the site. Site controls such as signs or markers could be installed to physically limit access to portions of the site and to identify areas of restricted use.

LUCs can be effective tools for mitigating potential human health risks posed by elevated concentrations of lead in site soils but may do little to minimize exposure to ecological receptors. LUCs have been retained for further evaluation.

7.4. Engineering Controls

Engineering controls involve the use of containment technologies which serve as source control by preventing direct contact with the lead contaminated soil. The engineering controls do not treat the lead contamination, nor do they reduce the amount of toxicity of the material. Capping technologies could be used separately or in combination, in certain Decision Units or in a central soil repository, or in other land use projects, to prevent contact with the lead in soil. Each of the engineering technologies is described in the following subsections.

7.4.1. Soil Capping

Isolation in the form of capping was evaluated as a potential response technology because of the difficulty in treating the volume of contaminated soil. Capping involves the construction of a surface barrier to prevent direct exposure to underlying lead contaminated soil. Surface controls such as re-vegetating can reduce windblown or water erosion of contaminated soil. However, capping would require some long-term maintenance, and construction and maintenance of a cap may affect site operations and future development.

Soil caps are constructed using either soil covers or low permeability clay layers to prevent contact and off-site transport of soils. Soil caps could be used directly to cover the lead contaminated soil with a protective layer, preventing contact with the contaminated soil. The advantage of soil capping is that contaminated soils remain in place, eliminating the need for excavation, transport and disposal.

The effectiveness of capping technologies with regard to minimizing contact is well documented. However, the Refuge is home to high seasonal winds and fine grained sandy soils. The use of a soil (sand) cap as a standalone option may not meet the RAOs without land use restrictions and vegetation management.

The use of a soil cap is easily implemented but would require land use restrictions to maintain the integrity of the cap. Natural vegetation at the site would quickly take hold in the newly placed soil cap. The native grasses would provide stability and minimize wind or rain erosion. The soil-capping option was retained for additional evaluation.

7.4.2. Geosynthetics

The geosynthetics alternative consists of the use of geotextile fabrics and geomembrane barriers. Geotextile fabrics are woven from synthetic material and made to withstand both chemical degradation and biodegradation. The fabric could be placed over untreated or undisturbed lead contaminated soils, effectively separating them from clean fill cap material. Geomembranes can be used as either a physical or visual barrier to separate the clean soil cover from underlying contaminated soil. Geomembrane barriers also have applicability as cover material over a soil disposal pile to prevent surface water infiltration and control migration of contaminants. These types of covers, however, are more costly than other soil covers.

The effectiveness of geosynthetics with regard to minimizing contact is well documented. However, the use of geosynthetics alone would result in a loss of nesting bird habit and the liners may degrade over time. The average life expectancy of a 40-mil liner is 40 years. The loss of habitat is not acceptable. The use of geotextiles is technically feasibly but would require the transport and installation of the materials to a remote location.

Failures of a geomembrane liner below grade is unlikely, but possible. The installation of a geomembrane liner (either as a cap on a consolidation unit or as a barrier in an excavation) would require that long term inspection be implemented. If failure is noted, the liner would have to either be repaired or replaced.

The use of a geotextile cap as a stand-alone option, may not meet the RAOs, but in conjunction with other alternatives (such as in an engineered multilayer cap), a geotextile cap may assist in meeting RAOs. The use of geotextiles was retained for additional evaluation.

7.5. Excavation and Disposal

Excavation involves the removal of lead contaminated soil through the physical removal of soil. Soil with lead at concentrations above the PCG can be either partially or totally removed. Soil excavation may be difficult and costly, particularly if the area contains trees, shrubs and walkways. Soil excavation would be conducted using conventional construction equipment such as track excavators, backhoes, bulldozers, and/or front-end loaders.

Erosion control measures may be necessary, especially in areas adjacent to surface water or wetlands, to prevent impacts to surrounding areas.

The excavated soil would be sampled and analyzed for TCLP lead to determine whether the soil is hazardous. If the TCLP sampling results exceed the regulatory limits, the associated soil would be considered hazardous, and would need to be disposed in a licensed hazardous waste disposal facility. If TCLP sampling results are below the regulatory limits, the associated soil would be considered non-hazardous.

Following excavation, confirmation soil sampling for lead would be conducted using a combination of fixed lab testing and XRF testing to verify that lead contaminated soil was successfully removed. All excavated areas would be backfilled with clean soil and re-graded.

Excavation and disposal is feasible and was thus retained as an applicable technology for further evaluation.

7.5.1. Partial Removal

Partial removal of soil consists of excavation of portions of the site containing the highest concentrations of lead and leaving behind deeper contaminated soils. It is anticipated that the top 1-foot of soil would be removed in each Decision Unit. The distance out from the buildings would vary from 15 to 50 feet. It is likely that partial removal would be used in conjunction with barrier and capping technologies (use of a geotextile membrane). The removal of the top 1-foot of soil and replacement with clean soil will remove the exposure pathway for nesting birds.

The limitation of partial excavation is the need for extensive testing to carefully delineate the soils to be removed. However, the cost for testing may be offset by the lower removal, transportation, and disposal costs for smaller quantities of soil. All excavated soil contaminated at concentrations exceeding the PCG will require appropriate disposal. This option will be retained for further evaluation.

7.5.2. Complete Removal

Complete removal is the excavation of soil to a predetermined depth around each building. Complete excavation may not be appropriate because soil at deeper depths may not pose an unacceptable risk. Complete removal would eliminate the exposure of receptors to all contaminated soil, substantially meeting the RAOs. Preliminary estimates indicate that costs for full removal across the entire site are extremely high. A preliminary volume estimate for full removal at Decision Unit 1 (cable buildings) alone is nearly 10,400 cubic yards and approximately 2,500 cubic yards of debris. In order to excavate the entire site to the cleanup level of 75 mg/kg, it is anticipated that over 55,000 cubic yards of soil and construction debris would be generated. Full removal may be practical at portions of the Decision Units. This option has been retained for evaluation.

7.5.3. Off-site Disposal

Disposal options must be considered with either partial or total excavation. The lead contaminated soil removed from the site will require disposal in a secure facility. Several options exist for disposal of lead contaminated soil, including off-site disposal. Soil for off-site disposal would require characterization to verify that the waste meets the acceptance criteria of the disposal facility. Off-site disposal would minimize or eliminate the mobility of the contaminants by placing the soil in a permitted facility. Off-site disposal does not reduce the toxicity or volume of the contaminant. The TCLP results from the 2010 investigation were below the TCLP limit of 5 mg/l. It is anticipated that the excavated soils would not be considered a hazardous waste. Because the soil contains COC at concentrations below RCRA disposal levels but above site screening criteria, the soil must be disposed of at facilities approved by the EPA (40 CFR 300.440).

Off-site disposal will be effective in removing the contaminated media and can be implemented, but becomes more costly as soil volumes increases. Costs to implement are very high. This option was retained for further evaluation for the disposal of controlled asbestos (ACM), LBP removed from the buildings and for soil disposal.

7.5.4. On-site Consolidation

A soil repository could be constructed on-site to facilitate treatment, storage and disposal of wastes associated with site remediation. A consolidation unit would be constructed to store wastes (including contaminated soil and other waste materials) from the site. A possible location for the consolidation unit is the former R-2 water storage unit, which has the capacity to store approximately 28,000 cubic yards of material. The material (demolition debris or bulk sand) would be transported to the R-2 unit in dump trucks and placed in the R-2 unit. On-site consolidation could also include the construction of various containment cells near each Decision Unit. The conceptual design for the consolidation unit would involve the placement and compaction of excavated soils and construction debris in the unit or units. The consolidation units would be closed after disposal is complete. A final cover system would be installed. The surface of the cover would be designed to minimize erosion, bird nesting and surface water intrusion. The cap could be constructed of a geomembrane or concrete.

On-site consolidation will be effective in isolating the contaminated media and can be implemented, but becomes more costly as the volume of soil and debris increases. Costs to implement are moderate to high. This option was retained for further evaluation.

7.6. In-Situ Treatment

In-situ treatment refers to the physical or chemical treatment of soil in place. Treatments include soil flushing, solidification, stabilization, electrokinetic separation or phytoremedation. Due to site conditions and the large surface area of proposed treatment areas and potential ecological habitat disturbance and destruction, the use of in-situ treatment will not be retained for further evaluation. A number of these technologies are discussed under the ex-situ treatment options.

7.7. Ex Situ Treatment

Ex-situ treatment refers to the treatment of soils after excavation. A number of ex-situ treatment options for lead are available. The following sections detail a number of ex-situ treatment options.

7.7.1. Solidification/Stabilization

Solidification/stabilization involves the excavation of contaminated soil and the physical encapsulation of mobile contaminants within an inert matrix (stabilization) or the reduction of material toxicity/mobility through chemical treatment or alteration (fixation). Two methods of stabilization are appropriate for lead contamination and consist of pozzolanic stabilization and phosphate addition.

7.7.1.1. POZZOLANIC STABILIZATION

Pozzolanic stabilization of soil consists of the addition of a solidifying agent such as Portland cement or fly ash to the soil to form a monolith, similar to concrete. The pozzolan would be added to site soil using a pug mill or other soil mixing system. The use of a stabilization agent may be

used to minimize long term monitoring requirements, or concerns about geomembrane failures because the site soil is not considered a hazardous waste. The use of pozzolanic stabilization may be considered for the placement of excavated material in an on-site consolidation unit. The advantage of pozzolanic stabilization is that treatment materials are inexpensive and readily available. The disadvantage is that stabilization increases the volume of the material. This option will be retained for further evaluation.

7.7.1.2. PHOSPHATE STABILIZATION

The formation of lead phosphates, such as pyromorphite, occurs naturally in the presence of sufficient concentrations of phosphate and lead. Lead phosphates are highly stable lead minerals that have been demonstrated to be less bioavailable due to their low solubility. Phosphate addition is a chemical stabilization procedure in which phosphate salts are added to soil either by solid or liquid addition and mixing. Phosphate ions combine with lead to form the less soluble lead phosphate complexes. Although the lead is not removed from the site, it becomes less bioavailable because the lead that occurs in the soil as lead-phosphate is less likely to be absorbed when ingested than in untreated soil. Phosphate stabilization is routinely used to treat metals in soil for disposal purposes.

Although recently completed bench-scale studies suggest that phosphate addition would effectively reduce bioavailability of lead, additional treatability testing would be necessary to further evaluate the effectiveness, feasibility and dosage requirements of this emerging technology.

The use of phosphate stabilization requires the input of additional chemicals and is limited by mixing techniques and soil types. Phosphate stabilization has been eliminated from further consideration in this EE/CA.

7.7.2. Chemical Treatment

Chemical treatment includes chemical extraction, chemical reduction/oxidation and soil washing. Chemical extraction uses chemicals to separate hazardous contaminants from soil. Chemical reduction and oxidation concerts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile and/or inert. Soil washing uses liquids and pH-controlled chemical additives to scrub excavated soils, removing contaminants and concentrating them for further treatment.

All of these options have a very high implementation costs and are more difficult to implement. Chemical treatment has been eliminated from future consideration in this EE/CA.

7.7.3. Thermal Treatment

Thermal treatment requires the heating of contaminated materials to encourage the volatilization and oxidation of metals. This process may also result in the vitrification of the contaminated matrix into a glass-like non-leachable matrix. Utilization of thermal treatment would most likely meet the RAOs, but is very difficult to implement and has a very high cost to implement. Thermal treatment has been screened from further consideration in this EE/CA.

7.7.4. Extraction Treatments

There are two general extraction processes, soil washing and acid leaching. Soil washing uses a washing solution and mechanical agitation to extract the lead from the soil. The acid leaching process converts lead sulfate and lead dioxide to lead carbonate. Both options are primarily used at sites with soil with high organic matter content. The soils at the Refuge are primarily fine to coarse grain sand with little organics. Due to the limited potential, high costs and the difficulty in implementing, the use of extraction treatments has not been retained for further consideration in this EE/CA.

7.8. Actions to Address Other Non-Soil Sources of Lead

The FWS is aware that lead in the environment at the site originates from many sources. In addition to the identified soil exposure pathway, which the above listed technologies will address, other important sources of lead exposure are interior and exterior LBP and lead contaminated interior dust. CERCLA and the NCP limit Superfund authority to address interior lead-based paint. For example, CERCLA Section 104(a)(3)(B) limits the EPA's liability to respond to releases within residential structures as follows – Section 104(a)(3):

> *"Limitations on Response. The President shall not provide for removal or remedial action under this section in response to a release or threat of release…from products which are part of the structure of, and result in exposure within, residential buildings or business or community structures…"*

The above cited section of CERCLA generally limits the lead agencies authority to respond to LBP inside a structure. However, the lead agency has authority to conduct response actions addressing a release of LBP from the exterior of homes to prevent recontamination of soils that have been remediated.

All removal options include the need for proper personal protective equipment (PPE) and site preparation including the use of plastic drop cloths, containment areas and decontamination zones.

A number of LBP remediation options are available. It is anticipated that a combination of the LBP removal and encapsulations options will be used at the Refuge. All options are readily implementable with average costs. The following sections discuss each of the LBP abatement options.

7.8.1. Hand Scraping and Sanding

Hand scraping of LBP includes the use of dry or wet sandpaper, rasps, wire brushes and scrapers. Hand scraping will be primarily used on wooden structures where there is a potential for damage due to mechanical removal methods. The use of hand scraping and sanding will be the most likely option used to abate historic structures.

7.8.2. Chemical Strippers

The use of chemical strippers can assist with LBP removal. A solvent or alkaline based paint stripper is used to assist in the removal of the paint. The stripper is normally applied with a brush

or roller and occasionally using a sprayer. The paint is typically removed using hand scraping techniques.

7.8.3. Machine Sanding

Machine sanding involves the use of high-efficiency particulate air (HEPA) filter fitted sanding machines. The Refuge currently has a number of Pentex HEPA filter sanders. Machine sanding can be used on structures that are not constructed of wood. Previous work at Midway has indicated that the use of machine sanding on the wood structures causes damage to the wood.

7.8.4. Water Blasting

Water blasting involves the use of pressure washers to remove peeling paint from the exterior of structures. In the past, water blasting has been used to remove LBP at the site. The use of water blasting may be used on the concrete structures and the structures covered with corrugated transite or metal siding.

7.8.5. Abrasive Blasting

Abrasive blasting uses large pressure blasters to remove paint using an abrasive media, such as sand or proprietarily blasting media. The use of abrasive blasting can be destructive and care must be taken when this option is used. It is unlikely that abrasive blasting will be used at the site.

7.8.6. Building Demolition

This EE/CA evaluates a limited number of buildings for demolition. The historic Cable Buildings (Buildings 619, 623, 626, and 628), the Marine Barracks (Buildings 578 and 579) and the aboveground storage tanks (ASTs) at the former fuel farm will be considered for demolition. While demolition may be practical for a number of additional structures, previous cost estimates (GeoEngineers, 2003 and FWS, 2004) have indicated that large scale demolition is currently impractical due to costs. As previously discussed, the demolition of the Cable Buildings and the barracks may be considered an adverse affect under the existing MOA with SHPD. The FWS will consult with SHPD on modifying the MOU to allow the removal of the structures.

7.8.7. Encapsulation Painting

Encapsulation is the process that makes LBP inaccessible by providing a barrier between the LBP and the environment. This barrier is formed using a liquid applied coating (with or without reinforcement materials) or an adhesively bonded covering material. While encapsulant systems may also be attached to a surface using mechanical fasteners, the primary means of attachment for an encapsulant is bonding of the product to the surface (either by itself or through the use of an adhesive). Encapsulation depends upon a successful bond between the surface of the existing paint film and the encapsulant for performance.

Various types of encapsulant products are available, including non-reinforced liquids (such as paint), liquid coatings reinforced with cloth or mat and materials adhered with an adhesive (i.e. new wall systems). For the site, the most likely encapsulation option is non-reinforced paint.

Encapsulation paint can be used in two methods. The first is the repainting of structures without conducting LBP removal (using one of the methods discussed above). The second is to use the

encapsulation paint after LBP removal has been conducted. Due to the poor condition of most of the painted structures at the Refuge, it is unlikely that encapsulation paint could be applied without some level of removal preparation (removal of large paint chips and peeled paint).

A number of encapsulation paints are available including Lead Stop and Ecobond® LBP by Metal Treatment Technologies. The advantage to the Ecobond® product is that it contains a conversion technology that also assists in chemically stabilizing and converting the lead into a less hazardous form.

8.0 DEVELOPMENT OF REMOVAL ACTION ALTERNATIVES

Removal technologies and options were identified based on site contaminants, characteristics, and removal action objectives. These were screened for effectiveness, implementability and relative cost. Removal alternatives were assembled using those technologies and options that passed the screening. These suites or groups of alternatives are evaluated and compared against one another in terms of their ability to meet the overall project objectives.

For planning purposes, the development of the removal action alternatives have been broken down by Decision Units, as discussed in Section 1.0 of this EE/CA. We have assumed that implementation costs of many of the group's technologies will be shared across each Decision Unit. During the comparative analysis of the alternatives (Section 9.0) the alternatives that are substantially similar are grouped together. In addition, we have assumed that a number of logistical requirements costs would be shared across each Decision Unit (such as barge mobilization fees, equipment fees, etc). The alternatives that were assembled are briefly described below.

8.1. Decision Unit 1

Decision Unit 1 includes Buildings 619, 623, 626, 628 and 643 (Cable Buildings) and the soil surrounding the buildings. Based on results of the removal action technology screening process, seven removal action alternatives were selected for detailed analysis.

The alternatives include:

- Alternative 1 – No action.
- Alternative 2 – Abatement of lead from Building 643 and the demolition of the remaining structures with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the contaminated soils and demolition debris in the consolidation unit.
- Alternative 3 – Abatement of lead from Building 643 and the demolition of the remaining structures with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the demolition debris and soil using ex-situ soil stabilization methods in a consolidation unit.
- Alternative 4 – Abatement of lead from Building 643 and the demolition of the remaining structures and the installation of a geomembrane and soil cap. On-site disposal of the demolition debris in the consolidation unit.

- Alternative 5 - Abatement of lead from Building 643 and the demolition of the remaining structures with limited excavation and the installation of a geomembrane and a soil cap. Off-site disposal of the demolition debris and soil.
- Alternative 6 - Abatement of lead from Building 643 and the demolition of the remaining structures with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the building debris in the consolidation unit and on-site disposal of soils using ex-situ soil stabilization methods in a containment cell constructed near the Decision Unit.
- Alternative 7 – Removal of structural members and abatement of lead from all Cable Buildings with limited excavation and the installation of a geomembrane and a soil cap.

8.1.1. Decision Unit 1, Alternative 1 – No Action

This alternative consists of no further action and leaving the site as is. Implementation of the No Action alternative would not reduce the risks to human and ecological receptors.

8.1.2. Decision Unit 1, Alternative 2 – Abatement of lead from Building 643 and the demolition of the remaining structures with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the contaminated soils and demolition debris in the consolidation unit.

Under Alternative 2, the exterior LBP from Building 643 would be removed to the extent practical using a combination of hand techniques. Upon completion, the exterior wood would be painted with two coats of lead encapsulation paint. The remaining cable buildings would be demolished. Prior to demolition, the accessible ACM present in each structure would be removed and stored in containers, pending off-site disposal. This alternative includes standard demolition practices using excavators, loaders and other equipment. Dust suppression will be required to contain any potential airborne contaminant.

Building materials and debris would require size reduction as appropriate. This can generally be achieved using demolition equipment (i.e., crushing with the excavator bucket or shearing). The building debris would be transported to the consolidation unit via dump truck for on-site disposal. Approximately 2,600 cubic yards of demolition debris would be generated. As discussed in Section 7.0, the containment unit will be capped when completed to minimize the potential for future releases of the contaminated material.

Approximately 3,500 cubic yards of contaminated surface and subsurface soils would be excavated from the areas surrounding the buildings and transported to the on-site consolidation unit. This assumes that an area up to 50-feet out from each side of the buildings to a depth of 1-foot would be excavated. This excavation targets the removal of the soils most likely to be encountered by nesting birds and removes the most highly contaminated soils.

The soil would be excavated using standard excavation equipment. Standard construction mitigation measures (such as silt fences) would be implemented and stormwater and dust control measures would be taken. A site-specific Health and Safety Plan would be implemented to ensure compliance with Occupational Safety and Health Administration (OSHA) standards during construction, monitoring and maintenance activities.

Following excavation, confirmation soil samples would be collected from the bottom and the sidewalls of the excavation to assess the remaining concentrations of lead in soil. Once the confirmation sampling was complete, site restoration would be performed. A geomembrane would be placed at the bottom of the excavations. The geomembrane will serve a number of purposes, including: 1) acting as a demarcation layer; 2) providing a barrier between the remaining contaminated soils and nesting birds; and 3) providing a means to know if erosion or other mechanisms have the potential to expose the remaining contaminated soil. The actual design of the geomembrane would be determined at the implementation phase, but we have assumed that a 30 or 45-milimeter liner with a 30 to 50 year anticipated life span would be used.

The excavation would be backfilled with clean soil and re-graded. An additional 2-foot of clean soil (total of 3-foot of clean soil) will be placed on top of the excavation. This will provide additional clean soil for burrowing bird habitat and will not limit burrow depths. It is assumed that the clean soil would be taken from the excess sand that has accumulated between the fuel pier and the cargo pier. Based on preliminary calculations, the volume of sand located between the fuel pier and the cargo pier is approximately 25,000 to 30,000 cubic yards.

8.1.3. Decision 1, Alternative 3 – Abatement of lead from Building 643 and the demolition of the remaining structures with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the demolition debris and soil using ex-situ soil stabilization methods in a consolidation unit

Alternative 3 is substantially similar to Alternative 2, except that the excavated soils and demolition debris would be stabilized using Portland cement. While the excavated soils do not fail TCLP testing, the use of the stabilized mixture may minimize concerns about long term liner failure that may expose ecological receptors to lead contamination. Excavated soils would be placed in the R-2 unit and mixed with 2 to 5 percent Portland cement, cement kiln dust or other stabilization agent. The mixture would be tilled in lifts within the R-2 unit. The tilling would be completed using equipment fitted with standard farm implementation equipment (such as a disk). Alternatively, mixing may be performed using the excavator bucket. Once mixed, water would be added to allow for the mixture to harden, similar to standard concrete. After the lift had dried, another level of material and soil could be added.

All other actions under this alternative are the same as Alternative 2.

8.1.4. Decision Unit 1, Alternative 4 – Abatement of lead from Building 643 and the demolition of the remaining structures and the installation of a geomembrane and soil cap. On site disposal of the demolition debris in the consolidation unit

Alternative 4 involves many of the same actions as Alternative 2 and 3, except no contaminated soil would be excavated. After the removal of the buildings and the abatement of the exterior lead from Building 643, the contaminated soil would be graded and the entire Decision Unit would be covered with a geomembrane. Once the membrane was in place, 3 feet of clean soil would be placed on top of the membrane. Under this alternative, the only material moved to the R-2 unit would be the 2,600 cubic yards of demolition debris.

8.1.5. Decision Unit 1, Alternative 5 - Abatement of lead from Building 643 and the demolition of the remaining structures with limited excavation and the installation of a geomembrane and a soil cap. Off-site disposal of the demolition debris and soil.

Under Alternative 5, the exterior LBP from Building 643 would be removed to the extent practical using a combination of hand techniques. Upon completion, the exterior wood would be painted with two coats of lead encapsulation paint. The remaining cable buildings would be demolished. Prior to demolition, the accessible ACM present in each structure would be removed and stored in containers, pending off-site disposal. This alternative includes standard demolition practices using excavators, loaders and other equipment. Dust suppression will be required to contain any potential airborne contaminant.

Building materials and debris would require size reduction as appropriate. This can generally be achieved using demolition equipment (i.e., crushing with the excavator bucket or shearing). The building debris would be transported by dump truck to a staging near the Seaplane Hangar for future loading onto a transportation barge. Approximately 3,500 cubic yards of contaminated surface and subsurface soils would be excavated from the areas surrounding the buildings and transported to the staging area near the Seaplane Hangar.

Building debris and contaminated soil from a number of Decision Units will be staged near the Seaplane Hangar. The staging area will consist of a bermed area (concrete blocks, dirt or other methods) lined with a geomembrane. In addition, the stockpile would be covered. Once the stockpile reaches approximately 10,000 cubic yards, a dedicated tug and barge will be used to transport the material from Midway to the continental United States for disposal. Upon arrival at Midway, the barge would be lined with plastic and a ramp would be set-up between the seawall and the barge. Materials for disposal would be bulk loaded onto the barge and placed for transportation.

The disposal barge can hold 14,000 tons of debris and soil. For cost purposes, transportation and disposal prices will be shared across each Decision Unit, based on the volume of debris and soil generated by that Decision Unit.

The remaining portion of this alternative is substantially similar to Alternative 2, including excavation techniques, liner placement and backfilling requirements.

8.1.6. Decision Unit 1, Alternative 6 - Abatement of lead from Building 643 and the demolition of the remaining structures with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the building debris in the consolidation unit and on-site disposal of soils using ex-situ soil stabilization methods in a containment cell constructed near the Decision Unit.

Alternative 6 is similar to Alternative 3, except that contaminated soil would be removed down to 1 feet bgs, removing the most highly contaminated soil. The building materials would be transported to the R-2 unit for consolidation disposal. Approximately 3,500 cubic yards of contaminated soil would be removed from the Decision Unit and staged near the excavation area. A second excavation would be advanced near the Decision Unit to six feet bgs. The second excavation will be approximately 10,500 cubic yards in size. Once the excavation reaches 6 feet bgs, the contaminated soil removed from the Decision Unit would be placed in the bottom of the second

excavation and mixed with 2 to 5 percent Portland cement or cement kiln dust (or other stabilization agent). Mixing will be performed using the excavator bucket. Once mixed, water would be added to allow for the mixture to harden, similar to standard concrete.

Once the contaminated soil has been placed in the second excavation and consolidated with the Portland cement, the contaminated soil would be covered with soils removed from the second excavation. The remaining portion of the clean soil from the second excavation would be used to place a 3-foot cap on the soils left in place at the Decision Unit.

8.1.7. Decision Unit 1, Alternative 7 - Alternative 7 – Removal of structural members and abatement of lead from all Cable Buildings with limited excavation and the installation of a geomembrane and a soil cap.

The alternative to abate lead paint and manage the Cable Buildings as stipulated in the June 4, 2009 MOA between the FWS and the Hawaii SHPD was considered and determined to be infeasible as described below. The paint removal process would begin at Buildings 619, 623, 626 and 628 after hazardous structural members including steel rafters, wood plank roofing material and concrete verandahs have been dismantled and removed. The remaining concrete core and foundations of Buildings 619, 623, 626, 628 would be maintained and abated of lead paint using hand scraping and chemical strippers.

As with all the alternatives in Decision Unit 1, this alternative would stabilize and maintain Building 643 in its present form and the building will remain on site. Lead paint will be abated from Building 643 by hand scraping and chemical strippers in conformance with the Secretary of Interior's Standards for the Treatment of Historic Properties. This alternative would have been considered a No Adverse Effect, because the Cable Building compound would remain as agreed upon and stipulated in the 2009 MOA.

This alternative was determined to be infeasible due to significant safety and health concerns with performing the dismantling, hand scraping and attempted maintenance of Cable Buildings 619, 623, 626, and 628. There is also concern, due to the high levels of lead in soil found near and around Cable Buildings 619, 623, 626, 628 there may be entrainment of lead in soil under the foundations of the Cable Buildings due to burrowing birds. The removal of Cable Buildings 619,623, 626, and 628 will require consultation initiated by the FWS, and require modification of the 2009 MOA between the FWS and Hawaii SHPD.

Mechanized removal of soils from around the Cable Buildings may have an adverse effect on the National Register Cable Station property which may contain buried archeological deposits. Therefore, the selected alternative will require archaeological testing for the presence of significant cultural deposits. If testing determines such deposits are present, archaeological data recovery will likely be necessary before soils are removed. Subsequent mechanized soil removal will require the presence of an on-site archaeological monitor. Clean sand and a soil hardener, barrier, or concrete will be placed around Building 643 to prevent infiltration by burrowing birds. Mechanized removal of soil and associated mitigation measures will require consultation initiated by the FWS, and require modification of the 2009 MOA between the FWS and Hawaii SHPD.

8.2. Decision Unit 2

Decision Unit 2 includes Buildings 578 and 579 (Marine Barracks) and the soils surrounding the buildings. Based on results of the removal action technology screening process, five removal action alternatives were selected for detailed analysis.

An alternative to remove the asbestos transite siding by hand so that the material may be salvaged for reuse on other historic properties on Midway Atoll was considered and determined to be infeasible as described below. The lead paint component of Buildings 578 and 579 would be removed using hand scraping and chemical strippers in conformance with the Secretary of Interior's Standards for the Treatment of Historic Properties. Under this considered alternative, the buildings would remain standing after removal of the lead paint and transite siding. This alternative was considered and determined to be infeasible due to the prohibitive costs and time-frame associated with removal of transite siding by hand and hand scraping the lead based paint from Buildings 578 and 579. If full abatement of the LBP is completed, the action could take up to 40 days to complete. This additional time and effort would increase the estimated costs by $350,000 to $400,000.

The alternatives include:

- Alternative 1 – No action.
- Alternative 2 – Removal of asbestos transite siding and the demolition of the structures with excavation of contaminated soils. On-site disposal of the contaminated soils and demolition debris in a consolidation unit.
- Alternative 3 – Removal of asbestos transite siding and the demolition of the structures with excavation of contaminated soils. On-site disposal of the demolition debris and soil using ex-situ soil stabilization methods in a consolidation unit.
- Alternative 4 – Removal of asbestos transite siding and the demolition of the structures with the installation of a geomembrane and the capping of soils. Disposal of the demolition debris in the consolidation unit.
- Alternative 5 – Removal of asbestos transite siding and the demolition of the structures with excavation of contaminated soils. Off-site disposal of the demolition debris and soil.

8.2.1. Decision Unit 2, Alternative 1 – No Action

This alternative consists of no further action and leaving the site as is. Implementation of the No Action alternative would not reduce the risks to human and ecological receptors.

8.2.2. Decision Unit #2, Alternative 2 – Removal of asbestos transite siding and the demolition of the structures with excavation of contaminated soils. On-site disposal of the contaminated soils and demolition debris in a consolidation unit

Under Alternative 2, the exterior asbestos transite siding would be removed from Buildings 578 and 579 and stored in 20-foot containers for offsite disposal. Once the asbestos siding was removed, both structures would be demolished. The demolition debris (3,000 cubic yards total) would be transported and disposed of in the consolidation unit.

Approximately 1,400 cubic yards of contaminated surface and subsurface soils would be excavated from the areas surrounding the buildings and transported to the on-site consolidation unit. This assumes that an area up to 30-feet out from each side of the buildings to a depth of 2-feet would be excavated. This excavation targets the removal of soils with lead at concentrations above the PCG of 75 mg/kg.

The soil would be excavated using standard excavation equipment. Standard construction mitigation measures (such as silt fences) would be implemented and stormwater and dust control measures would be taken. A site-specific Health and Safety Plan would be implemented to ensure compliance with OSHA standards during construction, monitoring and maintenance activities.

Following excavation, confirmation soil samples would be collected from the bottom and the sidewalls of the excavation to document the remaining contamination. Once the confirmation sampling was complete, site restoration would be performed. The excavation would be backfilled with clean soil and re-graded. It is assumed that the clean soil would be taken from the excess sand that has accumulated between the fuel pier and the cargo pier.

Demolition of a historic property (Marine Barracks) is an Adverse Effect as per 36CFR800.5 of the National Historic Preservation Act. The chosen alternative will require consultation initiated by the FWS. Mitigation procedures will be negotiated with the Advisory Council on Historic Preservation, the Hawaii SHPD, interested parties, and Native Hawaiians and in accordance with the requirements stipulated in a Memorandum of Agreement.

8.2.3. Decision Unit 2, Alternative 3 – Removal of asbestos transite siding and the demolition of the structures with excavation of contaminated soils. On-site disposal of the demolition debris and soil using ex-situ soil stabilization methods in a consolidation unit

Alternative 3 is substantially similar to Alternative 2, except that the excavated soils and demolition debris would be stabilized using Portland cement. While the excavated soils do not fail TCLP testing, the use of the stabilized mixture may minimize concerns about long term leaching or liner failure that may expose ecological receptors to lead contamination. Excavated soils would be placed in the R-2 unit and mixed with 2 to 5 percent Portland cement, cement kiln dust or other stabilization agent. The mixture would be tilled in lifts within the R-2 unit. The tilling would be completed using equipment fitted with standard farm implementation equipment (such as a disk). Alternatively, mixing may be performed using the excavator bucket. Once mixed, water would be added to allow for the mixture to harden, similar to standard concrete. After the lift had hardened, another level of material and soil could be added.

Demolition of a historic property (Marine Barracks) is an Adverse Effect as per 36CFR800.5 of the National Historic Preservation Act. The chosen alternative will require consultation initiated by the FWS. Mitigation procedures will be discussed with the Advisory Council on Historic Preservation, the Hawaii SHPD, interested parties, and Native Hawaiians and in accordance with the requirements stipulated in a Memorandum of Agreement.

All other actions under this alternative are the same as Alternative 2.

8.2.4. Decision Unit 2, Alternative 4 – Removal of asbestos transite siding and the demolition of the structures with the installation of a geomembrane and the capping of soils. Disposal of the demolition debris in the consolidation unit

Under Alternative 4 the removal of the asbestos transite siding and the demolition of the two structures would be completed as discussed in Alternatives 2 and 3. After the removal of the buildings, the contaminated soil would be graded and the entire Decision Unit would be covered with a geomembrane. Once the membrane was in place, 3 feet of clean soil would be placed on top of the membrane. Under this alternative, the only material moved to the R-2 unit would be the demolition debris.

8.2.5. Demolition of a historic property (Marine Barracks) is an Adverse Effect as per 36CFR800.5 of the National Historic Preservation Act. The chosen alternative will require consultation initiated by the FWS. Mitigation procedures will be negotiated with the Advisory Council on Historic Preservation, the Hawaii SHPD, interested parties, and Native Hawaiians and in accordance with the requirements stipulated in a Memorandum of Agreement. Decision Unit 2, Alternative 5 – Removal of asbestos transite siding and the demolition of the structures with excavation of contaminated soils. Off-site disposal of the demolition debris and soil

Under Alternative 5, the exterior LBP would be abated as discussed in Alternatives 2, 3 and 4. The contaminated soil would be transported to the staging area near the Seaplane Hangar. Contaminated soil from a number of Decision Units will be staged near the Seaplane Hangar. The staging area will consist of a bermed area (concrete blocks, dirt or other methods) lined with a geomembrane. In addition, the stockpile would be covered. Once the stockpile reaches approximately 10,000 cubic yards, a dedicated tug and barge will be used to transport the material from Midway to the continental United States for disposal. Upon arrival at Midway, the barge would be lined with plastic and a ramp would be set-up between the seawall and the barge. Materials for disposal would be bulk loaded onto the barge and placed for transportation. The disposal barge can hold 14,000 tons of debris and soil. For cost purposes, transportation and disposal prices will be shared across each Decision Unit, based on the volume of debris and soil generated by that Decision Unit.

The remaining portion of this alternative is substantially similar to Alternative 2, including excavation techniques, health and safety needs and backfilling requirements.

Demolition of a historic property (Marine Barracks) is an Adverse Effect as per 36CFR800.5 of the National Historic Preservation Act. The chosen alternative will require consultation initiated by the FWS. Mitigation procedures will be discussed with the Advisory Council on Historic Preservation, the Hawaii SHPD, interested parties, and Native Hawaiians and the requirements stipulated in a Memorandum of Agreement.

8.3. Decision Unit 3

Decision Unit 3 includes Building 4203 (BOQ Bravo Barracks), Building 4212, and the lead contaminated soil in the vicinity of Buildings 4203, 4204, the Officers Quarters buildings 415, 416, 417, 418, 419, 421, 422, 423 and 424, residential duplexes including Buildings 4209, 4210, 4211 and 414. The exterior LBP has been removed and/or encapsulated for all the buildings in

this Decision unit, except Buildings 4203 and 4212. Based on results of the removal action technology screening process, five removal action alternatives were selected for detailed analysis. The alternatives include:

- Alternative 1 – No action
- Alternative 2 – Abatement of lead on the exterior of Buildings 4203 and 4212 with excavation of soils with lead at concentrations above the PCG. On-site disposal of the contaminated soils in a lined consolidation unit.
- Alternative 3 – Abatement of lead on the exterior of Buildings 4203 and 4212 with excavation of soils with lead at concentrations above the PCG. On-site disposal using ex-situ stabilization methods in a consolidation unit
- Alternative 4 – Abatement of lead on the exterior of Buildings 4203 and 4212 with the installation of a geomembrane and the capping of the soils.
- Alternative 5 – Abatement of lead on the exterior of Buildings 4203 and 4212 with excavation of soils with lead at concentrations above the PCG. Off-site disposal of the contaminated soils.

8.3.1. Decision Unit 3, Alternative 1 – No Action

This alternative consists of no further action and leaving the site as is. The No Action alternative would not reduce the risks to human and ecological receptors.

8.3.2. Decision Unit 3, Alternative 2 – Abatement of lead for the exterior of Building 4203 and 4212 with excavation of soils above the PCG. On-site disposal of the contaminated soils in a lined consolidation unit

Alternative 2 involved the abatement of the exterior lead from Buildings 4203 and 4212. LBP would be removed using a number of techniques including high water pressure and hand techniques. Upon completion, the exterior would be painted with two coats of lead encapsulation paint.

Approximately 2,000 cubic yards of lead contaminated surface and subsurface soils would be excavated from the areas surrounding the buildings and transported to the on-site consolidation unit. This assumes that an area up to 15-feet out from each side of most of the buildings to a depth of 1-foot would be excavated. This excavation targets the removal of the soils with lead at concentrations that exceed the PCG.

The soil would be excavated using standard excavation equipment. Standard construction mitigation measures (such as silt fences) would be implemented and stormwater and dust control measures would be taken. A site-specific Health and Safety Plan would be implemented to ensure compliance with OSHA standards during construction, monitoring and maintenance activities.

Following excavation, confirmation soil samples would be collected from the bottom and the sidewalls of the excavation to document the remaining contamination. Once the confirmation sampling was complete, site restoration would be performed. The excavation will be backfilled with clean soil and re-graded. It is assumed that the clean soil would be taken from the excess sand that has accumulated between the fuel pier and the cargo pier.

8.3.3. Decision Unit 3, Alternative 3 – Abatement of lead for the exterior of Buildings 4203 and 4212 with excavation of soils above the PCG. On-site disposal using ex-situ stabilization methods in a consolidation unit

Alternative 3 is substantially similar to Alternative 2, except that the excavated soils would be stabilized using Portland cement. While the excavated soils do not fail TCLP testing, the use of the stabilized mixture may minimize concerns about long term leaching or liner failure that may expose ecological receptors to lead contamination. Excavated soils would be placed in the R-2 unit and mixed with 2 to 5 percent Portland cement, cement kiln dust or other stabilization agent. The mixture would be tilled in lifts within the R-2 unit. The tilling would be completed using on-site equipment fitted with standard farm implementation equipment (such as a disk). Alternatively, mixing may be performed using the excavator bucket. Once mixed, water would be added to allow for the mixture to harden, similar to standard concrete. After the lift had dried, another level of material and soil could be added.

All other actions under this alternative are the same as Alternative 2.

8.3.4. Decision Unit 3, Alternative 4 – Abatement of lead for the exterior of Buildings 4203 and 4212 with the installation of a geomembrane and the capping of the soils

Under Alternative 4, the exterior LBP would be abated as discussed in Alternatives 2 and 3. After the abatement of the exterior lead from Buildings 4203 and 4212, the contaminated soil would be graded and the entire Decision Unit would be covered with a geomembrane. Once the membrane was in place, 3 feet of clean soil would be placed on top of the membrane. Under this alternative, no material would be disposed of in the R-2 unit.

8.3.5. Decision Unit 3, Alternative 5 – Abatement of lead on the exterior of Buildings 4203 and 4212 with excavation of soils with lead at concentrations above the PCG. Off-site disposal of the contaminated soils

Under Alternative 5, the exterior LBP would be abated as discussed in Alternatives 2, 3 and 4. The contaminated soil would be transported to the staging area near the Seaplane Hangar. Contaminated soil from a number of Decision Units will be staged near the Seaplane Hangar. The staging area will consist of a bermed area (concrete blocks, dirt or other methods) lined with a geomembrane. In addition, the stockpile would be covered. Once the stockpile reaches approximately 10,000 cubic yards, a dedicated tug and barge will be used to transport the material from Midway to the continental United States for disposal. Upon arrival at Midway, the barge would be lined with plastic and a ramp would be set-up between the seawall and the barge. Materials for disposal would be bulk loaded onto the barge and placed for transportation.

The disposal barge can hold 14,000 tons of debris and soil. For cost purposes, transportation and disposal prices will be shared across each Decision Unit, based on the volume of debris and soil generated by that Decision Unit.

The remaining portion of this alternative is substantially similar to Alternative 2, including excavation techniques, health and safety needs and backfilling requirements.

8.4. Decision Unit 4

Decision Unit 4 includes the Midway Mall (Building 259), Buildings 2403, 2404 and the contaminated soils around these buildings. Based on results of the removal action technology screening process, five removal action alternatives were selected for detailed analysis. The alternatives include:

- Alternative 1 – No action.
- Alternative 2 – Abatement of lead on the exterior of Buildings 259, 2403, and 2404 with the excavation of soils with lead at concentrations above the PCG. On-site disposal of the contaminated soils in the consolidation unit.
- Alternative 3 – Abatement of lead for the exterior of Buildings 259, 2403, and 2404 with excavation of soils with lead at concentrations above the PCG. On-site disposal using ex-situ stabilization methods in a consolidation unit.
- Alternative 4 – Abatement of lead for the exterior of Buildings 259, 2403, and 2404 with the installation of a geomembrane and soil cap.
- Alternative 5 – Abatement of lead for the exterior of Buildings 259, 2403, and 2404 with excavation of soils with lead at concentrations above the PCG. Off-site disposal of soil.

8.4.1. Decision Unit 4, Alternative 1 – No Action

This alternative consists of no further action and leaving the site as is. The No Action alternative would not reduce the risks to human and ecological receptors.

8.4.2. Decision Unit 4, Alternative 2 – Abatement of lead for the exterior of Buildings 259, 2403, and 2404 with the excavation of soils above the PCG. On-site disposal of the contaminated soils in the consolidation unit

Alternative 2 involved the abatement of the exterior lead from Buildings 259, 2403 and 2404. LBP would be removed using a number of techniques including high water pressure and hand techniques. The theater (Building 259) is considered a historical structure. As such, all LBP abatement will be conducted in the gentlest manner practical. The FWS will need to consult with SHPO and Advisory Council once the alternative is chosen and prior to implementation. Upon completion, the exterior would be painted with two coats of lead encapsulation paint.

Approximately 2,000 cubic yards of contaminated surface and subsurface soils would be excavated from the areas surrounding the buildings and transported to the on-site consolidation unit. This assumes that an area up to 20-feet out from each side of the buildings to a depth of up to 3-feet would be excavated. This excavation targets the removal of the soils at concentrations above the PCG.

The soil would be excavated using standard excavation equipment. Standard construction mitigation measures (such as silt fences) would be implemented and stormwater and dust control measures would be taken. A site-specific Health and Safety Plan would be implemented to ensure compliance with OSHA standards during construction, monitoring and maintenance activities.

Following excavation, confirmation soil samples would be collected from the bottom and the sidewalls of the excavation to document the remaining contamination. Once the confirmation sampling was complete, site restoration would be performed. The excavation will be backfilled with clean soil and re-graded. It is assumed that the clean soil would be taken from the excess sand that has accumulated between the fuel pier and the cargo pier.

8.4.3. Decision Unit 4, Alternative 3 – Abatement of lead for the exterior of Buildings 259, 2403, and 2404 with excavation of soils above the PCG. On-site disposal using ex-situ stabilization methods in a consolidation unit

Alternative 3 is substantially similar to Alternative 2, except that the excavated soils would be stabilized using Portland cement. While the excavated soils do not fail TCLP testing, the use of the stabilized mixture may minimize concerns about long term leaching or liner failure that may expose ecological receptors to lead contamination. Excavated soils would be placed in the R-2 unit and mixed with 2 to 5 percent Portland cement, cement kiln dust or other stabilization agent. The mixture would be tilled in lifts within the R-2 unit. The tilling would be completed using onsite equipment fitted with standard farm implementation equipment (such as a disk). Alternatively, mixing may be performed using the excavator bucket. Once mixed, water would be added to allow for the mixture to harden, similar to standard concrete. After the lift had dried, another level of material and soil could be added.

All other actions under this alternative are the same as Alternative 2.

8.4.4. Decision Unit 4, Alternative 4 – Abatement of lead for the exterior of Buildings 259, 2403, 2404 with the installation of a geomembrane and soil cap

Under Alternative 4, the exterior LBP would be abated as discussed in Alternatives 2 and 3. After the abatement of the exterior lead from Buildings 259, 2403 and 2404, the contaminated soil would be graded and the entire Decision Unit would be covered with a geomembrane. Once the membrane was in place, 3 feet of clean soil would be placed on top of the membrane. Under this alternative, no material would be disposed of in the R-2 unit.

8.4.5. Decision Unit 4, Alternative 5 – Abatement of lead for the exterior of Buildings 259, 2403, and 2404 with excavation of soils with lead at concentrations above the PCG. Off-site disposal of soil

Under Alternative 5, the exterior LBP would be abated as discussed in Alternatives 2, 3 and 4. The contaminated soil would be transported to the staging area near the Seaplane Hangar. Contaminated soil from a number of Decision Units will be staged near the Seaplane Hangar. The staging area will consist of a bermed area (concrete blocks, dirt or other methods) lined with a geomembrane. In addition, the stockpile would be covered. Once the stockpile reaches approximately 10,000 cubic yards, a dedicated tug and barge will be used to transport the material from Midway to the continental United States for disposal. Upon arrival at Midway, the barge would be lined with plastic and a ramp would be set-up between the seawall and the barge. Materials for disposal would be bulk loaded onto the barge and placed for transportation.

The disposal barge can hold 14,000 tons of debris and soil. For cost purposes, transportation and disposal prices will be shared across each Decision Unit, based on the volume of debris and soil generated by that Decision Unit.

8.5. The remaining portion of this alternative is substantially similar to Alternative 2, including excavation techniques, health and safety needs and backfilling requirements. Decision Unit 5

Decision Unit 5 includes Building 5309 (Transmitter building) and the 5303 (R2 Unit) and the contaminated soils around the structures. Based on results of the removal action technology screening process, five removal action alternatives were selected for detailed analysis. The alternatives include:

- Alternative 1 – No action.
- Alternative 2 – Abatement of lead for the exterior of Buildings 5309 and 5303 with the excavation of soils above the PCG. On-site disposal of the contaminated soils in the consolidation unit.
- Alternative 3 – Abatement of lead for the exterior of Buildings 5309 and 5303 with excavation of soils above the PCG. On-site disposal using ex-situ stabilization methods in a consolidation unit.
- Alternative 4 – Abatement of lead for the exterior of Buildings 5309 and 5303 with the installation of a geomembrane and soil cap.
- Alternative 5 – Abatement of lead for the exterior of Buildings 5309 and 5303 with excavation of soils above the PCG. Off-site disposal of soil.

8.5.1. Decision Unit 5, Alternative 1 – No Action

This alternative consists of no further action and leaving the site as is. The No Action alternative would not reduce the risks to human and ecological receptors.

8.5.2. Decision Unit 5, Alternative 2 – Abatement of lead for the exterior of Buildings 5309 and 5303 with the excavation of soils above the PCG. On-site disposal of the contaminated soils in the consolidation unit

Alternative 2 involved the abatement of the exterior lead from Buildings 5309 and 5303 (R2 Unit). LBP would be removed using a number of techniques including high water pressure and hand techniques. Upon completion, the exterior of Building 5309 would be painted with two coats of lead encapsulation paint. No painting is planned for the R2 Unit (5303).

Approximately 1,000 cubic yards of contaminated surface and subsurface soils would be excavated from the areas surrounding the buildings and transported to the on-site consolidation unit. This assumes that an area up to 15-feet out from each side of the buildings to a depth of 1-foot would be excavated. This excavation targets the removal of the soils with lead at concentrations above the PCG.

The soil would be excavated using standard excavation equipment. Standard construction mitigation measures (such as silt fences) would be implemented and stormwater and dust control

measures would be taken. A site-specific Health and Safety Plan would be implemented to ensure compliance with OSHA standards during construction, monitoring and maintenance activities.

Following excavation, confirmation soil samples would be collected from the bottom and the sidewalls of the excavation to document the remaining contamination. Once the confirmation sampling was complete, site restoration would be performed. The excavation would then be backfilled with clean soil and re-graded. It is assumed that the clean soil would be taken from the excess sand that has accumulated between the fuel pier and the cargo pier.

8.5.3. Decision Unit 5, Alternative 3 – Abatement of lead for the exterior of Buildings 5309 and 5303 with excavation of soils above the PCG. On-site disposal using ex-situ stabilization methods in a consolidation unit.

Alternative 3 is substantially similar to Alternative 2, except that the excavated soils would be stabilized using Portland cement. While the excavated soils do not fail TCLP testing, the use of the stabilized mixture may minimize concerns about long term leaching or liner failure that may expose ecological receptors to lead contamination. Excavated soils would be placed in the R-2 unit and mixed with 2 to 5 percent Portland cement, cement kiln dust or other stabilization agent. The mixture would be tilled in lifts within the R-2 unit. The tilling would be completed using onsite equipment fitted with standard farm implementation equipment (such as a disk). Alternatively, mixing may be performed using the excavator bucket once mixed, water would be added to allow for the mixture to harden, similar to standard concrete. After the lift had dried, another level of material and soil could be added.

All other actions under this alternative are the same as Alternative 2.

8.5.4. Decision Unit 5, Alternative 4 – Abatement of lead for the exterior of Buildings 5309 and 5303 with the installation of a geomembrane and soil cap

Under Alternative 4, the exterior LBP would be abated as discussed in Alternatives 2 and 3. After the abatement of the exterior lead from Buildings 5309 and 5303, the contaminated soil would be graded and the entire Decision Unit would be covered with a geomembrane. Once the membrane was in place, 3 feet of clean soil would be placed on top of the membrane. Under this alternative, no material would be disposed of in the R-2 unit.

8.5.5. Decision Unit 5, Alternative 5 – Abatement of lead for the exterior of Buildings 5309 and 5303 with excavation of soils above the PCG. Off-site disposal of soil

Under Alternative 5, the exterior LBP would be abated as discussed in Alternatives 2, 3 and 4. The contaminated soil would be transported to the staging area near the Seaplane Hangar. Contaminated soil from a number of Decision Units will be staged near the Seaplane Hangar. The staging area will consist of a bermed area (concrete blocks, dirt or other methods) lined with a geomembrane. In addition, the stockpile would be covered. Once the stockpile reaches approximately 10,000 cubic yards, a dedicated tug and barge will be used to transport the material from Midway to the continental United States for disposal. Upon arrival at Midway, the barge would be lined with plastic and a ramp would be set-up between the seawall and the barge. Materials for disposal would be bulk loaded onto the barge and placed for transportation. The disposal barge can hold 14,000 tons of debris and soil. For cost purposes, transportation and disposal prices will

be shared across each Decision Unit, based on the volume of debris and soil generated by that Decision Unit.

The remaining portion of this alternative is substantially similar to Alternative 2, including excavation techniques, health and safety needs and backfilling requirements.

8.6. Decision Unit 6

Decision Unit 6 includes Buildings 393 (SKI warehouse), 356 (Transportation shop), 357 (Machine shop), 353 (Carpenter shop), 349 (Cold storage), 342 (Hazardous Materials storage), 363 (Torpedo shop/recycling) and 151 (Seaplane Hangar) and the contaminated soils around the structures. All of these buildings, except the Building 151 have had some level of exterior LBP removed or encapsulated. Based on GeoEngineers 2010 site visit, LBP is still present to some level on most of these structures. As such, we have assumed that additional LBP remediation will still be required. Based on results of the removal action technology screening process, six removal action alternatives were selected for detailed analysis. The alternatives include:

- Alternative 1 – No action.
- Alternative 2 – Abatement of lead for the exterior of the buildings with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the contaminated soils in the consolidation unit.
- Alternative 3 – Abatement of lead on the exterior of the buildings with limited excavation of soils and the installation of a geomembrane and a soil cap. On-site disposal using ex-situ stabilization methods in a consolidation unit.
- Alternative 4 – Abatement of lead for the exterior of the buildings and the installation of a geomembrane and soil cap.
- Alternative 5 – Abatement of lead on the exterior of the buildings with limited excavation of soils and the installation of a geomembrane and a soil cap. Off-site disposal of the soil.
- Alternative 6 – Abatement of lead on the exterior of the buildings with limited excavation of soils and the installation of a geomembrane and a soil cap. On-site disposal of the soils using ex-site soil stabilization methods in a containment cell constructed near the Decision Unit.

8.6.1. Decision Unit 6, Alternative 1 – No Action

This alternative consists of no further action and leaving the site as is. Implementation of the No Action alternative would not reduce the risks to human and ecological receptors.

8.6.2. Decision Unit 6, Alternative 2 – Abatement of lead for the exterior the buildings with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the contaminated soils in the consolidation unit

Alternative 2 includes the abatement of the exterior lead from the buildings. LBP would be removed using a number of techniques including high water pressure and hand techniques. Buildings 393, 356, 357, 353, 349, 343, 363, and 151 represent the core of the Albert Kahn designed industrial area of the Midway Naval Base. All of the buildings are considered historic properties, therefore, lead paint abatement procedures will be completed in the gentlest manner practical. The FWS will also need to consult with the SHPO and Advisory Council once the

alternative is chosen. Upon completion, the exterior of buildings except for Building 151 (Seaplane Hangar) will be painted with two coats of lead encapsulation paint.

Approximately 4,500 cubic yards of contaminated surface and subsurface soils would be excavated from the areas surrounding the buildings and transported to the on-site consolidation unit. This assumes that an area up to 50-feet out from each side of the buildings to a depth of 1-foot would be excavated. This excavation targets the removal of the soils most likely to be encountered by nesting birds. When practical, complete removal may be implemented around buildings, but the actual volume removed will be based on field analytical results during the implementation of the removal action.

The soil would be excavated using standard excavation equipment. Standard construction mitigation measures (such as silt fences) would be implemented and stormwater and dust control measures would be taken. A site-specific Health and Safety Plan would be implemented to ensure compliance with OSHA standards during construction, monitoring and maintenance activities.

Following excavation, confirmation soil samples would be collected from the bottom and the sidewalls of the excavation to document the remaining contamination. Once the confirmation sampling was complete, site restoration would be performed. A geomembrane would be place at the bottom of the excavation. The geomembrane will serve a number of purposes, including: 1) acting as a demarcation layer; 2) providing a barrier between the remaining contaminated soils and nesting birds; and 3) providing a means to know if erosion or other mechanisms have the potential to expose the remaining contaminated soil. The excavation would then be backfilled with clean soil and re-graded. If necessary, an additional 2-foot of clean soil (total of 3-feet of clean soil) could be placed on top of the excavation. This would provide additional clean soil for burrowing bird habitat and would not limit burrow depths to 12-inches. It is assumed that the clean soil would be taken from the excess sand that has accumulated between the fuel pier and the cargo pier.

8.6.3. Decision Unit 6, Alternative 3 – Abatement of lead for the exterior of the buildings with limited excavation of soils and the installation of a geomembrane and a soil cap. On-site disposal using ex-situ stabilization methods in a consolidation unit

Alternative 3 is substantially similar to Alternative 2, except that the excavated soils and demolition debris would be stabilized using Portland cement. While the excavated soils do not fail TCLP testing, the use of the stabilized mixture may minimize concerns about long term leaching or liner failure that may expose ecological receptors to lead contamination. Excavated soils would be placed in the R-2 unit and mixed with 2 to 5 percent Portland cement, cement kiln dust or other stabilization agent. The mixture would be tilled in lifts within the R-2 unit. The tilling would be completed using onsite equipment fitted with standard farm implementation equipment (such as a disk). Alternatively, mixing may be performed using the excavator bucket. Once mixed, water would be added to allow for the mixture to harden, similar to standard concrete. After the lift had dried, another level of material and soil could be added.

All other actions under this alternative are the same as Alternative 2.

8.6.4. Decision Unit 6, Alternative 4 – Abatement of lead for the exterior of the buildings and the installation of a geomembrane and soil cap

Under Alternative 4, the exterior LBP would be abated as discussed in Alternatives 2 and 3. After the abatement of the exterior lead, the contaminated soil would be graded and the entire Decision Unit would be covered with a geomembrane. Once the membrane was in place, 3 feet of clean soil would be placed on top of the membrane. Under this alternative, no material would be disposed of in the R-2 unit.

8.6.5. Decision Unit 6, Alternative 5 – Abatement of lead on the exterior of the buildings with limited excavation of soils and the installation of a geomembrane and a soil cap. Off-site disposal of the soil

Under Alternative 5, the exterior LBP would be abated as discussed in Alternatives 2, 3 and 4. The contaminated soil would be transported to the staging area near the Seaplane Hangar. Contaminated soil from a number of Decision Units will be staged near the Seaplane Hangar. The staging area will consist of a bermed area (concrete blocks, dirt or other methods) lined with a geomembrane. In addition, the stockpile would be covered. Once the stockpile reaches approximately 10,000 cubic yards, a dedicated tug and barge will be used to transport the material from Midway to the continental United States for disposal. Upon arrival at Midway, the barge would be lined with plastic and a ramp would be set-up between the seawall and the barge. Materials for disposal would be bulk loaded onto the barge and placed for transportation. The disposal barge can hold 14,000 tons of debris and soil. For cost purposes, transportation and disposal prices will be shared across each Decision Unit, based on the volume of debris and soil generated by that Decision Unit.

The remaining portion of this alternative is substantially similar to Alternative 2, including excavation techniques, health and safety needs and backfilling requirements.

8.6.6. Decision Unit 6, Alternative 6 – Abatement of lead on the exterior of the buildings with limited excavation of soils and the installation of a geomembrane and a soil cap. On-site disposal of the soils using ex-site soil stabilization methods in a containment cell constructed near the Decision Unit

Alternative 6 is similar to Alternative 3, except that contaminated soil would be removed down to 3 feet bgs, removing the contaminated soil nesting and burrowing birds may come in contact with. The building materials would be transported to the R-2 unit for consolidation disposal. Approximately 4,500 cubic yards of contaminated soil would be removed from the Decision Unit and staged near the excavation area. A second excavation would be advanced near the Decision Unit to six feet bgs. The second excavation will be approximately 13,500 cubic yards in size. Once the excavation reaches 6 feet bgs, the contaminated soil removed from the Decision Unit would be placed in the bottom of the second excavation and mixed with 2 to 5 percent Portland cement or cement kiln dust (or other stabilization agent). Mixing will be performed using the excavator bucket. Once mixed, water would be added to allow for the mixture to harden, similar to standard concrete.

Once the contaminated soil has been placed in the second excavation and consolidated with the Portland cement, the contaminated soil would be covered with soils removed from the second

excavation. The remaining portion of the clean soil from the second excavation would be used to place a 3-foot cap on the soils left in place at the Decision Unit.

8.7. Decision Unit 7

Decision Unit 7 includes Buildings 331 (Medical Clinic/Offices), 3504, 3502, 3503, 3512 and the contaminated soils around the structures. Based on results of the removal action technology screening process, five removal action alternatives were selected for detailed analysis. The alternatives include:

- Alternative 1 – No action.
- Alternative 2 – Abatement of lead for the exterior of the buildings and the excavation of soils above the PCG. On-site disposal of the contaminated soils in the consolidation unit.
- Alternative 3 – Abatement of lead for the exterior of the buildings and excavation of soils above the PCG. On-site disposal using ex-situ stabilization methods in a consolidation unit.
- Alternative 4 – Abatement of lead for the exterior of the buildings with the installation of a geomembrane and soil cap.
- Alternative 5 – Abatement of lead for the exterior of the buildings and excavation of soils above the PCG. Off-site disposal of soils.

8.7.1. Decision Unit 7, Alternative 1 – No Action

This alternative consists of no further action and leaving the site as is. Implementation of the No Action alternative would not reduce the risks to human and ecological receptors.

8.7.2. Decision Unit 7, Alternative 2 – Abatement of lead for the exterior of the buildings and the excavation of soils above the PCG. On-site disposal of the contaminated soils in the consolidation unit

Alternative 2 includes the abatement of the exterior lead from the buildings. LBP would be removed using a number of techniques including high water pressure and hand techniques. Upon completion, the exterior would be painted with two coats of lead encapsulation paint.

Approximately 3,200 cubic yards of contaminated surface and subsurface soils would be excavated from the areas surrounding the buildings and transported to the on-site consolidation unit. The excavation targets the removal of soils with lead concentrations above the PCG.

The soil would be excavated using standard excavation equipment. Standard construction mitigation measures (such as silt fences) would be implemented and stormwater and dust control measures would be taken. A site-specific Health and Safety Plan would be implemented to ensure compliance with OSHA standards during construction, monitoring and maintenance activities.

Following excavation, confirmation soil samples would be collected from the bottom and the sidewalls of the excavation to document the remaining contamination. Once the confirmation sampling was complete, site restoration would be performed. The excavation would them be backfilled with clean soil and re-graded. It is assumed that the clean soil would be taken from the excess sand that has accumulated between the fuel pier and the cargo pier.

8.7.3. Decision Unit 7, Alternative 3 – Abatement of lead for the exterior of the buildings and excavation of soils above the PCG. On-site disposal using ex-situ stabilization methods in a consolidation unit

Alternative 3 is substantially similar to Alternative 2, except that the excavated soils would be stabilized using Portland cement. While the excavated soils do not fail TCLP testing, the use of the stabilized mixture may minimize concerns about long term leaching or liner failure that may expose ecological receptors to lead contamination. Excavated soils would be placed in the R-2 unit and mixed with 2 to 5 percent Portland cement, cement kiln dust or other stabilization agent. The mixture would be tilled in lifts within the R-2 unit. The tilling would be completed using onsite equipment fitted with standard farm implementation equipment (such as a disk). Alternatively, mixing may be performed using the excavator bucket. Once mixed, water would be added to allow for the mixture to harden, similar to standard concrete. After the lift had hardened, another level of material and soil could be added.

All other actions under this alternative are the same as Alternative 2.

8.7.4. Decision Unit 7, Alternative 4 – Abatement of lead for the exterior of the buildings with the installation of a geomembrane and soil cap

Under Alternative 4, the exterior LBP would be abated as discussed in Alternatives 2 and 3. After the abatement of the exterior lead, the contaminated soil would be graded and the entire Decision Unit would be covered with a geomembrane. Once the membrane was in place, 3 feet of clean soil would be placed on top of the membrane. Under this alternative, no material would be disposed of in the R-2 unit.

8.7.5. Decision Unit 7, Alternative 5 – Abatement of lead for the exterior of the buildings and excavation of soils above the PCG. Off-site disposal of soils

Under Alternative 5, the exterior LBP would be abated as discussed in Alternatives 2, 3 and 4. The contaminated soil would be transported to the staging area near the Seaplane Hangar. Contaminated soil from a number of Decision Units will be staged near the Seaplane Hangar. The staging area will consist of a bermed area (concrete blocks, dirt or other methods) lined with a geomembrane. In addition, the stockpile would be covered. Once the stockpile reaches approximately 10,000 cubic yards, a dedicated tug and barge will be used to transport the material from Midway to the continental United States for disposal. Upon arrival at Midway, the barge would be lined with plastic and a ramp would be set-up between the seawall and the barge. Materials for disposal would be bulk loaded onto the barge and placed for transportation. The disposal barge can hold 14,000 tons of debris and soil. For cost purposes, transportation and disposal prices will be shared across each Decision Unit, based on the volume of debris and soil generated by that Decision Unit.

The remaining portion of this alternative is substantially similar to Alternative 2, including excavation techniques, health and safety needs and backfilling requirements.

8.8. Decision Unit 8

Decision Unit 8 includes the fuel storage tanks at the old fuel farm and the contaminated soils around the ASTs. Based on results of the removal action technology screening process, five removal action alternatives were selected for detailed analysis. The alternatives include:

- Alternative 1 – No action.
- Alternative 2 – Decommissioning of each AST by removal with excavation of soils from the Decision Unit. On-site disposal of the contaminated soils in a lined consolidation unit.
- Alternative 3 – Decommissioning of each AST by removal with excavation of soils from the Decision Unit. On-site disposal using ex-situ stabilization methods in a consolidation unit.
- Alternative 4 – Decommissioning of each AST by removal with placement of a geomembrane and capping of the soils.
- Alternative 5 – Decommissioning of each AST by removal with excavation of soils from the Decision Unit. Off-site disposal of soils.

8.8.1. Decision Unit #8, Alternative 1 – No Action

This alternative consists of no further action and leaving the site as is. Implementation of the No Action alternative would not reduce the risks to human and ecological receptors.

8.8.2. Decision Unit 8, Alternative 2 – Decommissioning of each AST by removal with excavation of soils from the Decision Unit. On-site disposal of the contaminated soils in a lined consolidation unit

Under Alternative 2, the ASTs at the old fuel farm would be decommissioned by removal. The removal would include the cleaning of each AST (as necessary). Based on similar previous work, the abatement of lead is not necessary. The use of a negative exposure assessment will be used to ensure worker safety. The scrap metal can be recycled with the paint present. The removal would include the use of heavy equipment and manual labor (welders, cutting, etc). The scrap metal generated during the decommissioning of the ASTs would be staged for future off-site recycling.

Approximately 800 cubic yards of contaminated surface and subsurface soils would be excavated from the areas within the lined bermed area and transported to the on-site consolidation unit.

The soil would be excavated using standard excavation equipment. Standard construction mitigation measures (such as silt fences) would be implemented and stormwater and dust control measures would be taken. A site-specific Health and Safety Plan would be implemented to ensure compliance with OSHA standards during construction, monitoring and maintenance activities.

Following excavation, confirmation soil samples would be collected from the bottom and the sidewalls of the excavation to document the remaining contamination. Once the confirmation sampling was complete, site restoration would be performed. The excavation would then be backfilled with clean soil and re-graded. It is assumed that the clean soil would be taken from the excess sand that has accumulated between the fuel pier and the cargo pier.

8.8.3. Decision Unit 8, Alternative 3 – Decommissioning of each AST by removal with excavation of soils from the Decision Unit. On-site disposal using ex-situ stabilization methods in a consolidation unit

Alternative 3 is substantially similar to Alternative 2, except that the excavated soils would be stabilized using Portland cement. While the excavated soils do not fail TCLP testing, the use of the stabilized mixture may minimize concerns about long term leaching or liner failure that may expose ecological receptors to lead contamination. Excavated soils would be placed in the R-2 unit and mixed with 2 to 5 percent Portland cement, cement kiln dust or other stabilization agent. The mixture would be tilled in lifts within the R-2 unit. The tilling would be completed using onsite equipment fitted with standard farm implementation equipment (such as a disk). Alternatively, mixing may be performed using the excavator bucket. Once mixed, water would be added to allow for the mixture to harden, similar to standard concrete. After the lift had dried, another level of material and soil could be added.

All other actions under this alternative are the same as Alternative 2.

8.8.4. Decision Unit 8, Alternative 4 – Decommissioning of each AST by removal with placement of a geomembrane and capping of the soils

Alternative 4 also involves the decommissioning of the ASTs, but under Alternative 4, no soils would be excavated. After the abatement of the exterior lead on the ASTs, the contaminated soil would be graded and the entire Decision Unit would be covered with a geomembrane. Once the membrane was in place, 3 feet of clean soil would be placed on top of the membrane. Under this alternative, no material would be disposed of in the R-2 unit.

8.8.5. Decision Unit 8, Alternative 5 – Decommissioning of each AST by removal with excavation of soils from the Decision Unit. Off-site disposal of soils

Under Alternative 5, the exterior LBP would be abated as discussed in Alternatives 2, 3 and 4. The contaminated soil would be transported to the staging area near the Seaplane Hangar. Contaminated soil from a number of Decision Units will be staged near the Seaplane Hangar. The staging area will consist of a bermed area (concrete blocks, dirt or other methods) lined with a geomembrane. In addition, the stockpile would be covered. Once the stockpile reaches approximately 10,000 cubic yards, a dedicated tug and barge will be used to transport the material from Midway to the continental United States for disposal. Upon arrival at Midway, the barge would be lined with plastic and a ramp would be set-up between the seawall and the barge. Materials for disposal would be bulk loaded onto the barge and placed for transportation. The disposal barge can hold 14,000 tons of debris and soil. For cost purposes, transportation and disposal prices will be shared across each Decision Unit, based on the volume of debris and soil generated by that Decision Unit.

The remaining portion of this alternative is substantially similar to Alternative 2, including excavation techniques, health and safety needs and backfilling requirements.

8.9. Decision Unit 9

Decision Unit 9 includes the remaining structures (except for the above ground water tanks near the runway) that are in use at Midway and the remaining contaminated soils. This Decision Unit is

broad based and includes storage buildings, pump house, lift stations and other ancillary structures. It is difficult to define the removal action area because of the number of structures, and the various sizes and state of disrepair of these structures. There may be historic properties included within this Decision Unit. The FWS will need to address the requirements of the NHPA on a case by case basis as the lead paint remediation procedures are developed for this Decision Unit.

GeoEngineers has relied on a number of planning level estimates prepared by the FWS and others to estimate the potential removal action areas for Decision Unit 9. Based on results of the removal action technology screening process, five removal action alternatives were selected for detailed analysis. The alternatives include:

- Alternative 1 – No action.
- Alternative 2 – Abatement of lead for the exterior of the structures with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the contaminated soils in the consolidation unit.
- Alternative 3 – Abatement of lead for the exterior of the structures with limited excavation of soils and the installation of a geomembrane and a soil cap. On-site disposal using ex-situ stabilization methods in a consolidation unit.
- Alternative 4 – Abatement of lead for the exterior of the structures and the installation of a geomembrane and soil cap.
- Alternative 5 – Abatement of lead for the exterior of the structures with limited excavation and the installation of a geomembrane and a soil cap. Off-site disposal of the contaminated soils.

8.9.1. Decision Unit 9, Alternative 1 – No Action

This alternative consists of no further action and leaving the site as is. Implementation of the No Action alternative would not reduce the risks to human and ecological receptors.

8.9.2. Decision Unit 9, Alternative 2 – Abatement of lead for the exterior of the structures with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the contaminated soils in the consolidation unit

Alternative 2 includes the abatement of the exterior lead from the structures. LBP would be removed using a number of techniques including high water pressure and hand techniques. Upon completion, the exterior of select structures would be painted with two coats of lead encapsulation paint.

Approximately 6,000 cubic yards of contaminated surface and subsurface soils would be excavated from the areas surrounding the structures and transported to the on-site consolidation unit. This assumes that approximately 50 percent of the estimated volume of contaminated soil in Decision Unit 9 will be excavated. This is only a conceptual level estimate because of the lack of sampling results around most of the remaining structures. The excavations will target the removal of the soils most likely to be encountered by nesting birds.

The soil would be excavated using standard excavation equipment. Standard construction mitigation measures (such as silt fences) would be implemented and stormwater and dust control

measures would be taken. A site-specific Health and Safety Plan would be implemented to ensure compliance with OSHA standards during construction, monitoring and maintenance activities.

Following excavation, confirmation soil samples would be collected from the bottom and the sidewalls of the excavation to document the remaining contamination. Once the confirmation sampling was complete, site restoration would be performed. A geomembrane would be placed at the bottom of the excavations. The geomembrane will serve a number of purposes, including: 1) acting as a demarcation layer; 2) providing a barrier between the remaining contaminated soils and nesting birds; and 3) providing a means to know if erosion or other mechanisms are exposing the remaining contaminated soil. The excavations would then be backfilled with clean soil and re-graded. If necessary, an additional 2-foot of clean soil (total of 3-foot of clean soil) could be placed on top of the excavation. This would provide additional clean soil for burrowing bird habitat and would not limit burrow depths to 12 inches. It is assumed that the clean soil would be taken from the excess sand that has accumulated between the fuel pier and the cargo pier.

8.9.3. Decision Unit 9, Alternative 3 – Abatement of lead for the exterior of the structures with limited excavation of soils and the installation of a geomembrane and a soil cap. On-site disposal using ex-situ stabilization methods in a consolidation unit

Alternative 3 is substantially similar to Alternative 2, except that the excavated soils would be stabilized using Portland cement. While the excavated soils do not fail TCLP testing, the use of the stabilized mixture may minimize concerns about long term leaching or liner failure that may be performed using the excavator bucket. Excavated soils would be placed in the R-2 unit and mixed with 2 to 5 percent Portland cement, cement kiln dust or other stabilization agent. The mixture would be tilled in lifts within the R-2 unit. The tilling would be completed using on-site equipment fitted with standard farm implementation equipment (such as a disk). Once mixed, water would be added to allow for the mixture to harden, similar to standard concrete. After the lift had dried, another level of material and soil could be added.

All other actions under this alternative are the same as Alternative 2.

8.9.4. Decision Unit 9, Alternative 4 – Abatement of lead for the exterior of the structures and the installation of a geomembrane and soil cap

Under Alternative 4, the exterior LBP would be abated as discussed in Alternatives 2 and 3. After the abatement of the exterior lead, the contaminated soil would be graded and the entire soils with lead at concentrations above the PCG in Decision Unit 9 would be covered with a geomembrane. Once the membrane was in place, 3 feet of clean soil would be placed on top of the membrane. Under this alternative, no material would be disposed of in the R-2 unit.

8.9.5. Decision Unit 9, Alternative 5– Abatement of lead for the exterior of the structures with limited excavation of soils and the installation of a geomembrane and a soil cap. Off-site disposal of contaminated soils

Under Alternative 5, the exterior LBP would be abated as discussed in Alternatives 2, 3 and 4. The contaminated soil would be transported to the staging area near the Seaplane Hangar. Contaminated soil from a number of Decision Units will be staged near the Seaplane Hangar. The staging area will consist of a bermed area (concrete blocks, dirt or other methods) lined with a

geomembrane. In addition, the stockpile would be covered. Once the stockpile reaches approximately 10,000 cubic yards, a dedicated tug and barge will be used to transport the material from Midway to the continental United States for disposal. Upon arrival at Midway, the barge would be lined with plastic and a ramp would be set-up between the seawall and the barge. Materials for disposal would be bulk loaded onto the barge and placed for transportation. The disposal barge can hold 14,000 tons of debris and soil. For cost purposes, transportation and disposal prices will be shared across each Decision Unit, based on the volume of debris and soil generated by that Decision Unit.

The remaining portion of this alternative is substantially similar to Alternative 2, including excavation techniques, health and safety needs and backfilling requirements.

9.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

Following the detailed analysis of each of the retained removal action alternatives, it is necessary to compare how each removal action alternative satisfied the evaluation criteria. Tables 9 through 17 describe the relative abilities of the removal action alternatives to meet the required criteria. While the site has nine Decision Units, the alternatives for most are the same. As such, the comparative analysis discussion below is centered on the overall site and to identify the advantages and disadvantages of each alternative relative to one another.

The evaluation criteria are grouped into three categories: effectiveness, implementability and cost.

Effectiveness criteria include: 1) overall protection of human health and the environment; 2) compliance with ARARs; 3) long-term effectiveness and permanence; 4) reduction of toxicity, mobility and volume through treatment; and 5) short-term effectiveness.

Implementability criteria includes the technical and administrative feasibility of implementing the removal action; availability of services and materials; and community acceptance of the removal action technology.

Costs include direct and indirect capital costs and long-term maintenance and operating costs. These criteria, with the exception of community acceptance, are used to differentiate among alternatives during the selection process. Community acceptance is evaluated in determining the final removal action selection.

- **Overall Protection of Human Health and the Environment.** The primary requirement for CERCLA removal actions is that they be protective of human health and the environment. A removal action is protective if it adequately eliminates, reduces, or controls all current and potential health risks. All pathways of exposure must be considered when evaluating the removal alternative. After the removal action is implemented, if hazardous substances remain without engineering or institutional controls, then the evaluation must consider unrestricted use and unlimited exposure for human and environmental receptors. For those sites where hazardous substances remain and unrestricted use and unlimited exposure are not allowable, engineering controls, institutional controls, or some combination of the two must be implemented to control exposure and thereby ensure reliable protection over time. In addition,

implementation of a removal action cannot result in unacceptable short-term risks or cross-media impacts with regard to human health and the environment.

- **Compliance with ARARs and TBCs.** Compliance with ARARs and TBCs is one of the statutory requirements for removal action selection. Fund-financed removal actions under CERCLA section 104 and removal actions pursuant to CERCLA section 106 shall, to the extent practicable considering the exigencies of the situation, attain ARARs under federal environmental, state environmental or facility siting laws. Alternatives are developed and refined throughout the EE/CA process to ensure that they will, to the extent practicable considering the exigencies of the situation, meet all of their respective ARARs or that there is a good rationale for obtaining a variance or exemption. During the detailed analysis, information on federal action-specific ARARs will be assessed, along with previously identified chemical-specific and location-specific ARARs.
- **Long-Term Effectiveness and Permanence.** This criterion reflects CERCLA's emphasis on implementing remedies that will ensure protection of human health and the environment in the future, and in the near term. In evaluating alternatives for their long-term effectiveness and the degree of permanence they afford, the analysis should focus on the residual risks that will remain at the site after the completion of the removal action. This analysis should include consideration of the following:
  - Degree of threat posed by the hazardous substances remaining at the site.
  - Adequacy of any controls (e.g., engineering and institutional controls) used to manage the hazardous substances remaining at the site.
  - Reliability of those controls.
  - Potential impacts on human health and the environment should the removal action fail, based on assumptions included in the reasonable maximum exposure scenario.
- **Reduction of Toxicity, Mobility and Volume through Treatment.** This criterion addresses the statutory preference for remedies that employ treatment as a principal element by ensuring that the relative performance of the various treatment alternatives in reducing toxicity, mobility, or volume will be assessed. Specifically, the analysis should examine the magnitude, significance, and irreversibility of reductions.
- **Short-Term Effectiveness.** This criterion examines the short-term impacts of the alternatives (i.e., impacts of the implementation) on the workers, or the surrounding environment, including the potential threat to human health and the environment associated with excavation, treatment, and transportation of hazardous substances. The potential cross-media impacts of the removal action and the time to achieve protection of human health and the environment are also evaluated. The time required to meet removal action objectives is also evaluated under this criterion.
- **Implementability.** Implementability considerations include the technical and administrative feasibility of the alternatives, as well as the availability of the goods and services (e.g., treatment, storage or disposal capacity) on which the viability of the alternative depends. Implementability considerations often affect the timing of various removal action alternatives (e.g., limitations on the season in which the removal action can be implemented, the number and complexity of materials-handling steps that must be followed and the need to secure technical services such as excavation services).

Cost. Cost encompasses all capital costs and operation and maintenance costs incurred over the life of the project. The focus during the detailed analysis is on the net present value of these costs. Costs are used to identify the least expensive (or most cost-effective) alternative that will achieve the removal action objectives. For purposes of calculating the present worth for the annual operating and maintenance costs, a 30-year maintenance life was used (EPA, 1996).

- **Community Acceptance.** This criterion refers to the community's comments on the removal action alternatives under consideration, where "community" is broadly defined to include all interested parties. These comments are taken into account throughout the EE/CA process.

9.1. Overall Protection of Human Health and the Environment

Except for Alternative 1, all alternatives discussed for each Decision Unit would be protective of human health and the environment by eliminating, reducing, or controlling risks posed by the contamination through engineering control/LUCs and/or removal of the contaminated soil. The degree of protection of human health and the environment provided by each of the alternatives, except for Alternative 1, is considered to be similar.

All alternatives, except for Alternative 1 are considered protective of human health because the contaminated surface and subsurface soils would be either properly managed in place using a geomembrane cap or disposed of at the on-site repository. Other reinforcing mechanisms such as excavation restrictions afford additional security to protect from future exposure to the contaminated soils that remain at the site.

9.2. Compliance with ARARs

Alternative 1 would not comply with ARARs. The remaining alternatives for each Decision Unit would primarily meet the location-specific, action-specific and chemical-specific ARARs. The proposed alternatives for Decision Unit 1 and Decision Unit 2 will require a modification to the MOA between the FWS and SHPD to address the potential demolition of the cable buildings and former Marine Barracks.

9.3. Long Term Effectiveness and Permanence

Alternative 1 does not provide long-term effectiveness and permanence. The risk associated with the contaminated soils would not be eliminated or controlled. The remaining alternatives for each Decision Unit would satisfy this criterion. Additionally, Five-Year Reviews would be performed to verify the protectiveness of the alternatives. Most alternatives would involve removing the contaminated soils thus eliminating the potential of contaminant migration into groundwater and adjacent surface water and supporting future ecological use at the site. Therefore, the alternatives that call for the removal of lead contaminated soil to levels below the PCG are more effective than alternatives that do not. Based on removal being more effective, Alternative 4 (capping only) has scored lower than alternatives that include excavation of contaminated soil. Alternative 5 (off-site disposal) has scored higher than other alternatives because the removal of the contaminated soil provides greater long term effectiveness and permanence. Using Alternative 5, soils will not be stored in a containment cell, eliminating the potential for future failure of the containment cell.

Alternatives 3 and 6 have scored higher than Alternative 2. Alternatives 3 and 6 use Portland cement to solidify the lead contaminated soil, providing a more permanent fix than the use of a geomembrane liner (Alternative 2). While each alternative removes the risk, Alternatives 3 and 6 have less potential to fail over time. While there is a potential for the concrete to crack or crumble, the lead contamination will still be bound to the concrete, minimizing future exposure due to failures.

9.4. Reduction of Toxicity, Mobility and Volume Through Treatment

None of the alternatives contain treatment components as a part of the alternative. The nature of the site, the waste materials, and the land use are not conducive to the selection of a treatment-only alternative. A number of alternatives involve the use of Portland cement to further stabilize the lead in soil, potentially reducing toxicity and mobility.

9.5. Short-Term Effectiveness

Alternative 1 does not include any on-site construction and therefore would not have any short term construction-related impacts. However, Alternative 1 would not be an effective alternative because potential risks would continue to exist. The remaining alternatives for each Decision Unit have moderate to high impacts during construction. In general, the amount of impacts to construction workers, the community, and the environment is proportional to the volume of soils to be excavated and transported. Each alternative (except Alternative 6) will disturb a similar foot print in each Decision Unit. Alternative 6 requires the excavation of an additional consolidation unit near the Decision Unit. This additional excavation will disturb a larger area, which may affect a larger portion of wildlife. As such, Alternative 6 has scored lower than other alternatives.

Alternative 5 (off-site disposal) has the highest potential for cross-media impacts (loading soil onto a barge over the inner harbor) and transportation of contaminated soil across the Pacific Ocean. In addition, Alternative 5 requires double handling of the contaminated media. The first includes the excavation of the soils and transportation to the staging area. The second includes the loading of the stockpiled soils onto the barge. Alternative 5 has scored lower than other Alternatives.

Inhalation, dermal, and ingestion risks during excavation would be controlled through the use of dust suppression techniques, use of PPE, and restricted site access. Noise generated during excavation can be mitigated through engineering controls. Spill prevention measures such as tarps, liners, and covers could be implemented during transportation of excavated materials.

9.6. Implementability

Alternative 1 would be easily implemented because no actions are required. The remaining alternatives for each Decision Unit are implementable using existing and proven technologies, but these require various levels of coordination, planning and management.

Alternatives 2 through 6 each involve a work crew of between 10 and 15 people. In addition, these alternatives can only be primarily implemented during the time period when the majority of the birds are not present on the site. This period is generally July through October of each year. Based on a four month construction window, most alternatives will take 4 to 5 years to complete. Portions of each alternative may be implemented during nesting months. It is possible that

portions of the LBP abatement activities and painting activities can be conducted during nesting periods. Housing space is a concern due to the limited housing arrangements on Midway and the presence of visitors and other site contractors. It is likely that the FWS will need to obtain a waiver on the FWS existing management plan for Midway to allow for additional personnel. In addition, the FWS may need to consider the renovation or modification of existing lodging facilities to house the construction crews. A second option could include the use of mobile crew camps or crew barges. Costs for housing renovation or use of mobile crew options have not been included in the EE/CA.

Each alternative requires the use of outside equipment and services, including barges and heavy equipment. For all alternatives, equipment will need to be barged to Midway and stored on Midway for the duration of the project. In many cased, the equipment will be purchased so at the end of the project, the FWS will be considered the owner of the equipment.

Alternative 5 (off-site disposal) is the most difficult option to implement. This option requires the loading of bulk soil onto transportation barges (most likely on three separate occasions). This requires the coordination of additional barges into Midway. This Alternative also requires the design and implementation of a loading ramp and staging of a barge. Alternative 5 (off-site disposal) scored lower than other alternatives for implementability.

Excavation could be implemented with little difficulty because the excavation and disposal are widely used and well understood. Excavation and on-site consolidation can be completed using standard construction procedures and conventional earthmoving equipment. Construction of a consolidation unit has become a standard practice. The equipment and labor required to install the consolidation unit are readily available, but some of the required equipment must be transported to Midway.

Alternative 4 calls for no excavation, only the capping of soils in place. Due to the mound of soil that would be used (3-feet) above existing grade, it is likely that this alternative would be prone to wind and water erosion.

The use of a geomembrane liner (either as a cap for the consolidation unit or in an excavation) will require long-term monitoring. The liner will need to be evaluated periodically and failures will need to be repaired or replaced.

9.7. Costs

The dollar amount for each alternative is estimated in 2010 dollars with a performance period of 30 years. Tables 18 through 59 provide cost tables for each alternative for the nine Decision Units that includes a 15 percent contingency line item. Alternative 1 would not incur any cost and is the least expensive alternative under consideration. The following is a brief summary of the estimated costs for each Decision Unit.

Decision Unit 1 Buildings 619, 623, 626, 628, 643 (Cable Buildings) and the soils surrounding the structures.

- Alternative #2 – Abatement of lead on Building 643 and the demolition of the remaining structures with limited excavation and the installation of a geomembrane and a soil cap. On-

site disposal of the contaminated soils and demolition debris in the consolidation unit. Estimated cost - **$809,288.**

- Alternative #3 – Abatement of lead from Building 643 and the demolition of the remaining structures with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the demolition debris and soil using ex-situ soil stabilization methods in a consolidation unit - **$853,008.**
- Alternative #5 – Abatement of lead from Building 643 and the demolition of the remaining structures with limited excavation and the installation of a geomembrane and a soil cap. Off-site disposal of the demolition debris and soil - **$1,255,506.**
- Alternative #6 – Abatement of lead from Building 643 and the demolition of the remaining structures with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the building debris in the consolidation unit and on-site disposal of soils using ex-situ soil stabilization methods in a containment cell constructed near the Decision Unit - **$908,228.**

Decision Unit 2 Buildings 578, 579 (Marine Barracks) and the soils surrounding the structures.

- Alternative #2 – Removal of asbestos transite siding and the demolition of the structures with excavation of contaminated soils above the PCG. On-site disposal of the contaminated soils and demolition debris in a consolidation unit. Estimated cost - **$1,258,695**.
- Alternative #3 – Removal of asbestos transite siding and the demolition of the structures with excavation of contaminated soils. On-site disposal of the demolition debris and soil using ex-situ soil stabilization methods in a consolidation unit - **$1,304,216.**
- Alternative #5 – Removal of asbestos transite siding and the demolition of the structures with excavation of contaminated soils. Off-site disposal of the demolition debris and soil - **$2,047,988**.

Decision Unit 3 Building 4203 (Bachelors Office Quarters [BOQ] Bravo Barracks), Building 4212, and the lead contaminated soil in the vicinity of Buildings 4203, 4204, the Officers Quarters buildings 415, 416, 417, 418, 419, 421, 422, 423 and 424, residential duplexes including buildings 4209, 4210, 4211 and 414. The exterior LBP has been removed and/or encapsulated for all the buildings in this Decision unit, except Buildings 4203 and 4212

- Alternative #2 – Abatement of lead on the exterior of Buildings 4203 and 4212 with excavation of contaminated soils above the PCG. On-site disposal of the contaminated soils in a lined consolidation unit. Estimated cost - **$651,973**.
- Alternative #3 – Abatement of lead on the exterior of Buildings 4203 and 4212 with excavation of soils with lead at concentrations above the PCG. On-site disposal using ex-situ stabilization methods in a consolidation unit - **$733,215.**
- Alternative #5 – Abatement of lead on the exterior of Buildings 4203 and 4212 with excavation of soils with lead at concentrations above the PCG. Off-site disposal of the contaminated soils - **$1,287,850**.

Decision Unit 4 Building 259 (Midway Mall), Buildings 2403 and 2404.

- Alternative #2 – Abatement of lead on the exterior of Buildings 259, 2403, and 2404 with the excavation of soils above the PCG. On-site disposal of the contaminated soils in the consolidation unit. Estimated cost - **$894,422**.
- Alternative #3 – Abatement of lead for the exterior of Buildings 259, 2403, and 2404 with excavation of soils with lead at concentrations above the PCG. On-site disposal using ex-situ stabilization methods in a consolidation unit - **$898,084.**
- Alternative #5 – Abatement of lead for the exterior of Buildings 259, 2403, and 2404 with excavation of soils with lead at concentrations above the PCG. Off-site disposal of soil - **$1,431,705**.

Decision Unit 5 Building 5309 (the former Transmitter building) and 5303 (R2 Unit)

- Alternative #2 – Abatement of lead on the exterior of Building 5309 and 5303 with the excavation of soils with lead at concentrations above the PCG. On-site disposal of the contaminated soils in the consolidation unit. Estimated cost - **$502,473.**
- Alternative #3 – Abatement of lead for the exterior of Buildings 5309 and 5303 with excavation of soils above the PCG. On-site disposal using ex-situ stabilization methods in a consolidation unit - **$552,001**.
- Alternative #5 – Abatement of lead for the exterior of Buildings 5309 and 5303 with excavation of soils above the PCG. Off-site disposal of soil - **$1,028,812.**

Decision Unit 6 Buildings 393 (SKI warehouse,) 342 (hazardous materials storage), 356 (Transportation shop), 357 (Machine shop), Building 353 (carpenter shop) 349 (Cold storage), 363 (Torpedo shop/recycling) and 151 (Seaplane Hangar).

- Alternative #2 – Abatement of lead on the exterior the buildings with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the contaminated soils in the consolidation unit. Estimated cost - **$1,420,656.**
- Alternative #3 – Abatement of lead on the exterior of the buildings with limited excavation of soils and the installation of a geomembrane and a soil cap. On-site disposal using ex-situ stabilization methods in a consolidation unit - **$1,472,093**.
- Alternative #5 – Abatement of lead on the exterior of the buildings with limited excavation of soils and the installation of a geomembrane and a soil cap. Off-site disposal of the soil - **$2,257,518**.
- Alternative #6 – Abatement of lead on the exterior of the buildings with limited excavation of soils and the installation of a geomembrane and a soil cap. On-site disposal of the soils using ex-site soil stabilization methods in a containment cell constructed near the Decision Unit - **$1,533,115.**

Decision Unit 7 Buildings 331 (Medical Clinic/Offices), 3502 (Galley), 3503 (Barracks C), 3504 (Barracks D) and 3512 (Gymnasium)

- Alternative #2 – Abatement of lead on the exterior the buildings with the excavation of soils with lead at concentrations above the PCG. On-site disposal of the contaminated soils in the consolidation unit. Estimated cost - **$719,835.**

- Alternative #3 – Abatement of lead for the exterior of the buildings and excavation of soils above the PCG. On-site disposal using ex-situ stabilization methods in a consolidation unit - **$784,899**.
- Alternative #5 – Abatement of lead for the exterior of the buildings and excavation of soils above the PCG. Off-site disposal of soils - **$1,440,397.**

Decision Unit 8 Fuel storage tanks located at the old fuel farm.

- Alternative #2 – Decommissioning of each AST by removal with excavation of soils with lead at concentrations above the PCG. On-site disposal of the contaminated soils in a lined consolidation unit. Estimated cost - **$596,526.**
- Alternative #3 – Decommissioning of each AST by removal with excavation of soils from the Decision Unit. On-site disposal using ex-situ stabilization methods in a consolidation unit - **$634,232**.
- Alternative #5 – Decommissioning of each AST by removal with excavation of soils from the Decision Unit. Off-site disposal of soils - **$1,024,391.**

Decision Unit 9 The remaining buildings or structures that are in use by the FWS. Decision Unit 9 originally included the water storage tanks near the airport. It is our understanding that the FWS has requested that the current Refuge management firm CII paint the water tanks. It is our understanding that CII will be using a lead encapsulating paint. As such, GeoEngineers has not addressed the water tanks in this EE/CA.

- Alternative #2 – Abatement of lead for the exterior of the structures with limited excavation of soils above the PCG and the installation of a geomembrane and a soil cap. On-site disposal of the contaminated soils in the consolidation unit. Estimated cost - **$1,805,510**.
- Alternative #3 – Abatement of lead for the exterior of the structures with limited excavation of soils and the installation of a geomembrane and a soil cap. On-site disposal using ex-situ stabilization methods in a consolidation unit - **$1,867,251**.
- Alternative #5 – Abatement of lead for the exterior of the structures with limited excavation and the installation of a geomembrane and a soil cap. Off-site disposal of the contaminated soils - **$2,914,766.**

The following is a summary of the total estimated costs for all decision units by alternative:

- Alternative #2 – $8,659,974. If Alternative #6 is chosen for Decision Units 1 and 6 the estimated cost is $8,871,373.
- Alternative #3 – $9,098,999. If Alternative #6 is chosen for Decision Units 1 and 6 the estimated cost is $9,215,241.
- Alternative #5 – $14,688,933. If Alternative #6 is chosen for Decision Units 1 and 6 the estimated cost is $15,760,554.

In general, the use of the soil cap is the least expensive option and offsite disposal is the most expensive option. In addition, excavation and on-site consolidation using a geomembrane cover cap is slightly less expensive than the consolidation unit with stabilization methods.

The overall estimated costs to complete the project may be as much as 10 to 20 percent lower than listed in the EE/CA costs tables. A number of scenarios may assist in lowering the project costs. The EE/CA assumed that each Decision Unit was primarily completed independent of one another. The following could lower project costs.

- Completion of multiple Decision Units in a singular mobilization. This would decrease mobilization costs and would allow for project schedules to be condensed. This would also reduce oversight costs, project management costs and logistical costs.
- Negotiation with the Refuge on equipment rental price. For the EE/CA rental prices were based on the daily rates provided by Refuge personnel. Due to the duration of this work, lower fees may be negotiable.
- Obtain a waiver to allow for on-site disposal of the ACM. Similar projects in the Pacific (Johnston Atoll) were able to obtain a waiver for the on-site disposal of ACM. If a waiver was obtained, the off-site disposal costs for ACM would be eliminated.
- Use of pre-scheduled barges or other forms of transportation. It may be possible to mobilize equipment to the site on previously scheduled delivery barges. This would eliminate the need for project specific barges.

9.8. Community Acceptance

It is anticipated that the alternatives that call for excavation of soils will receive higher community acceptance than those options that only call for capping. Due to the limited involvement of outside stakeholders to date, we have assumed that all Alternatives are considered substantially similar, except for Alternative 1.

10.0 RECOMMENDED REMOVAL ACTION ALTERNATIVE

The recommended alternative for the non-time-critical removal action for each Decision Unit is listed below. Each recommended alternative also includes the management and disposal of the existing ACM and LBP debris and chips currently stored on Midway.

- Decision Unit 1, Alternative #3 – Abatement of lead on Building 643 and the demolition of the remaining structures with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the demolition debris and soil using ex-situ soil stabilization methods in a consolidation unit. Estimated cost - $853,008. Alternative 6 should be considered in storage space in the proposed R2 consolidation unit become an issue. Decision Unit 2, Alternative #3 – Removal of asbestos transite siding and the demolition of the structures with excavation of contaminated soils above the PCG. On-site disposal of the contaminated soils and demolition debris using ex-situ soil stabilization methods in a consolidation unit. Estimated cost - $1,304,216.
- Decision Unit 3, Alternative #3 – Abatement of lead on the exterior of Buildings 4203 and 4212 with excavation of contaminated soils above the PCG. On-site disposal of the contaminated soils using ex-situ soil stabilization methods in a consolidation unit. Estimated cost - $733,215.

- Decision Unit 4, Alternative #3 – Abatement of lead on the exterior of Buildings 259, 2403, and 2404 with the excavation of soils above the PCG. On-site disposal of the contaminated soils using ex-situ soil stabilization methods in a consolidation unit. Estimated cost - $598,084.
- Decision Unit 5, Alternative #3 – Abatement of lead on the exterior of Buildings 5309 and 5303 with the excavation of soils with lead at concentrations above the PCG. On-site disposal of the contaminated soils using ex-situ soil stabilization methods in a consolidation unit. Estimated cost - $552,001.
- Decision Unit 6, Alternative #3 – Abatement of lead on the exterior the buildings with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the contaminated soils in using ex-situ soil stabilization methods in a consolidation unit. Estimated cost - $1,472,093. Alternative 6 should be considered if storage space in the proposed R2 consolidation unit becomes an issue.
- Decision Unit 7, Alternative #3 – Abatement of lead on the exterior the buildings with the excavation of soils with lead at concentrations above the PCG. On-site disposal of the contaminated soils using ex-situ soil stabilization methods in a consolidation unit. Estimated cost - $784,899.
- Decision Unit 8, Alternative #3 – Decommissioning of each AST by removal with excavation of soils with lead at concentrations above the PCG. On-site disposal of the contaminated soils using ex-situ soil stabilization methods in a consolidation unit. Estimated cost - $634,232.

Decision Unit 9, Alternative #3 – Abatement of lead from the exterior of the structures with limited excavation of soils above the PCG and the installation of a geomembrane and a soil cap. On-site disposal of the contaminated soils using ex-situ soil stabilization methods in a consolidation unit. Estimated cost - $1,867,251. In general, the excavation and on-site disposal in a consolidation unit using ex-situ stabilization methods has a slightly higher estimated cost than the use of capping in place only or excavation and on-site disposal in a consolidation unit with a geomembrane. The excavation of soils with concentrations of lead above the PCG provides a greater level of protection to the environment. Subsequent to stakeholder input, the selected removal action alternatives should be documented in the Action Memorandum for the site.

Based on the analysis of the 2010 lead in soil analytical results, and the condition of the exterior paint on each structure the Decision Units with the highest potential to affect wildlife are Decision Unit 1, Decision Unit 6 and Decision Unit 2. The following is the ranking of risk for the Decision Units.

1. Decision Unit 1
2. Decision Unit 6
3. Decision Unit 2
4. Decision Unit 4
5. Decision Unit 7
6. Decision Unit 5

7. Decision Unit 3
8. Decision Unit 8
9. Decision Unit 9

11.0 BIBLIOGRAPHY

Code of Federal Regulations Title 40: "Protection of Environment, Chapter I, Subchapter J, Part 300 – National Oil and Hazardous Substances Pollution Contingency Plan." Available from epa.gov/docs/epacfr40/Chapt-I.info/subch-j.htm; Internet.

Federal Occupational Health, Environmental Evaluation, Sand Island, Midway Atoll National Wildlife Refuge, Midway Atoll, Federal Occupational Health Report, January 14, 2010.

Finkelstein, M.E., Gwiazda, R.H., and Smith, D.R., Lead Poisoning of Seabirds: Environmental Risks from Leaded Paint at a Decommissioned Military Base, Environmental Science and Technology, 37:3256–3260, 2003.

Finkelstein, M., Midway Atoll National Wildlife Refuge Lead Poisoning of Laysan Albatross Chicks, Unpublished report, June 2004.

Finkelstein, M., Supplemental Information: Lead Poisoning of Laysan Albatross Chicks on Midway Atoll, U.C. Santa Cruz Report, Santa Cruz, CA, August 2006.

Finkelstein, M., Nakagawa, M., Sievert, P., Klavitter, J., and Doak, D., Assessment of Demographic Risk Factors and Management Priorities: Impacts on Juveniles Substantially Affect Population Viability of a Long-lived Seabird, Pacific Seabird Group Annual Meeting, Hakodate, Hokkaido, Japan, February18 - 26, 2009.

Klavitter, J., June 2007 Survey for "Droop Wing" Laysan Albatross Chicks at Midway Atoll National Wildlife Refuge, U.S. Fish and Wildlife Service Report, July 16, 2007.

Ogden Environmental and Energy Services, Midway Island Survey: Asbestos and Lead-based Paint Survey Report, Honolulu, Hawaii, February 18, 1994.

R.S. Means, "Environmental Remediation Cost Data, Means Cost Works 2003." Reed Construction Data, Kingston, Mass, 2003.

Sharon K., Taylor, S.K., Gorbics, C.S., Luciani, E., Zeeman, C., Gibson, J., and Little, A., Ecological Risk Assessment for Lead in Soil and Laysan Albatross Chicks on Sand Island, Midway Atoll National Wildlife Refuge, U.S. Fish and Wildlife Service Report, Carlsbad, CA, December 16, 2009.

Sileo, L. and Fefer, S.I., Paint Chip Poisoning of Laysan Albatross at Midway Atoll, Pacific Ocean, Journal of Wildlife Diseases, 23:432–437, 1987.

U.S. Environmental Protection Agency (EPA), "Risk Assessment Guidance for Superfund (RAGS), Volume 1: Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Interim." Publication 9285.7-01B, EPA Office of Emergency and Remedial Response, Washington, DC, 1991.

U.S. Environmental Protection Agency, "Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA," Office of Solid Waste and Emergency Response, PB93-963402, 9360.0-32, EPA540-R-93-057, August 1993.

U.S. Environmental Protection Agency, "Guidelines for Ecological Risk Assessment," EPA/630/R-95/002F, Office of Research and Development, Washington, D.C., 1998.

U.S. Environmental Protection Agency, "Test Methods for Evaluating Solid Waste, Chemical Methods," April 1998. Available at: http://www.epa.gov/epaoswer/hazwaste/test/sw846.htm

U.S. Environmental Protections Agency, "Guidelines for Ecological Risk Assessment. Final." Risk Assessment Forum, EPA/630/R-95/002F, Washington DC, April 1998.

U.S. Environmental Protection Agency, "Guidance for the Data Quality Objectives Process," August 2000.

U.S. Environmental Protections Agency, "Risk Assessment Guidance for Superfund Volume II – Environmental Evaluation Manual," EPA/540/1-89/001, Washington, DC, November 2001.

U.S. Environmental Protection Agency, "EPA Requirements for Quality Assurance Project Plans," EPA QA-R-5, March 2001.

U.S. Environmental Protection Agency, "Guidance on Choosing a Sampling Design for Environmental Data Collection," EPA QA/G-5S, December 2002.

U.S. Environmental Protection Agency, "Guidance for Quality Assurance Project Plans," EPA QA/G-5, December 2002.

U.S. Environmental Protection Agency, The IEUBK Model. Washington, DC, 2004. http://www.epa.gov/superfund/programs/lead/ieubk.htm

U.S. Fish and Wildlife Service (USFWS), 2004a, Phases for the Lead-based Paint Removal at Midway Atoll NWR, U.S. Fish and Wildlife Service Report, July 2004.

U.S. Fish and Wildlife Service, 2004b, Temporary Lead-based Paint Abatement at Midway Atoll National Wildlife Refuge, U.S. Fish and Wildlife Service Project Proposal, Honolulu, HI, July 14, 2004.

U.S. Environmental Protections Agency, "Ecological Soil Screening Levels." 2005. Online Address: http://www.epa.gov/ecotox/ecossl/ Updated March.

U.S. Environmental Protection Agency, "Regional Screening Levels of Chemical Contaminants at Superfund Sites." Developed by Oak Ridge National Laboratory under an Interagency Agreement with the EPA, April 2009.

U.S. Fish and Wildlife Service, Ecological Risk Assessment for Lead in Soil and Laysan Albatross Chicks on Sand Island, Midway Atoll National Wildlife Refuge, U.S. Fish and Wildlife Service, September 24, 2009.

Work, T.M., and Smith, M.R., Lead Exposure in Laysan Albatross Adults and Chicks in Hawaii: Prevalence, Risk Factors and Biochemical Effects, Archives of Environmental Contamination and Toxicology 31: 115-119, 1996.

Work, T. M., Smith, M.R., and Duncan, R., Necrotizing Enteritis as a Cause of Mortality in Laysan Albatross, Diomedia Immutabilis, Chicks on Midway Atoll, Hawaii, Avian Diseases 42:1-5, 1998.

12.0 ACRONYMS

ACM – asbestos containing material
ARAR – applicable or relevant and appropriate requirements
ARRA – American Recovery and Reinvestment Act
AST – aboveground storage tanks
ASTM – ASTM International Standard Practices
BERA – Baseline Ecological Risk Assessment
bgs – below ground surface
BRAC – Base Realignment and Closure
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act
CFR – Code of Federal Regulations
CII – Chugach Industries Inc.
CLEAN - Comprehensive Long-Term Environmental Action Navy
COCs – contaminants of concern
CPECs – contaminants of potential ecological concern
CSM – conceptual site model
DI – de-ionized
DOI – U.S. Department of the Interior
DQOs – data quality objectives
DTSC – California Department of Toxic Substances Control
Eco-SSL – EPA's Ecological Soil Screening Level
Ecology – Washington State Department of Ecology
EDI – estimated daily intake
EE/CA – Engineering Evaluation/Cost Analysis
EPA – U.S. Environmental Protection Agency
ERA – Ecological Risk Assessment
ESA – Endangered Species Act
FS – Focused Feasibility Study
FWS – U.S. Fish and Wildlife Services

g/day – gram per day
HEPA – high-efficiency particulate air
HERD – Human and Ecological Risk Division
HQ – hazard quotient
IDW – investigation-derived waste
LBP – lead-based paint
LOAEL – lowest observed adverse effect level
LOE – line-of-evidence
LUCs – Land Use Controls
MBTA – Migratory Bird Treaty Act
mg/kg - milligrams per kilogram
mg/kg/day – intake per kilogram of body weight per day
mg/kg-ww – milligrams per kilogram - wet weight
mg/l – milligrams per liter
MOA – memorandum of agreement
MRL – method reporting limit
MTCA – Model Toxics Cleanup Act
NAF – Naval Air Facility
NCP – National Oil and Hazardous Substances Contingency Plan
NOAEL – no observed adverse effect level
O&M – operations and maintenance
Ogden – Ogden Environmental and Energy Service
OHM – OHM Remediation Services Corporation
OSHA – Occupational Safety and Health Administration
PAH – polycyclic aromatic hydrocarbons
PCB – polychlorinated biphenyl
PCGs – preliminary cleanup goals
PPE – personal protection equipment
ppm – parts per million
QA – quality assurance
QC – quality control
QA/QC – quality assurance/quality control
QAPP – Quality Assurance Project Plan
RAA – removal action alternatives
RAOs – removal action objectives
RBC – risk-based concentration
Refuge or Site – Midway Atoll National Wildlife Refuge
RI – Remedial Investigation
RPDs – relative percent differences
RSLs – EPA Regional Screening Levels
SARA – Superfund Amendments and Reauthorization Act
SERA – Screening Ecological Risk Assessment
SHPD – Hawaiian State Historic Preservation Department
SRE – Streamlines Risk Evaluation
SVOC – semivolatile organic compounds
T&E – threatened and endangered

TBC – to be considered
TCLP – toxicity characteristic leaching procedure
TOC – total organic carbon
TRV – toxicity reference values
XRF – x-ray fluorescence instrument
°F – degrees Fahrenheit
µg/dL – microgram per deciliter
µg/g-dw – micrograms per gram – dry weight
µg/g-ww – micrograms per gram – wet weight

TABLES

GeoEngineers

Table 1

Summary of Chemical Analytical Data
XRF Field Data Results

2009 - U.S. Fish and Wildlife Ecological Risk Assessment
Midway Atoll National Wildlife Refuge

Sample ID	Sample Date	depth (inches)	Pb (ppm)
BACKGROUND			
1	4/19/08	0	<13
	4/19/08	3	<13
	4/19/08	6	<13
	4/19/08	9	<12
	4/19/08	12	<12
2	4/24/08	0	<13
	4/24/08	3	<12
	4/24/08	6	<13
	4/24/08	9	<11
	4/24/08	12	<13
3	4/24/08	0	<12
	4/24/08	3	**18**
	4/24/08	6	**20**
	4/24/08	9	**15**
	4/24/08	12	**24**
5	4/17/08	0	**22**
	4/17/08	3	**33**
	4/17/08	6	**24**
	4/17/08	9	**19**
	4/17/08	12	<14
6	4/17/08	0	**13**
	4/17/08	3	<13
	4/17/08	6	<13
	4/17/08	9	**15**
	4/17/08	12	**20**
7	4/19/08	0	**21**
	4/19/08	3	**16**
	4/19/08	6	<13
	4/19/08	9	<13
	4/19/08	12	**18**
8	4/24/08	0	**25**
	4/24/08	3	**25**
	4/24/08	6	**19**
	4/24/08	9	**33**
	4/24/08	12	**18**
9	4/17/08	0	**52**
	4/17/08	3	**89**
	4/17/08	6	<13
	4/17/08	9	<14
	4/17/08	12	**17**
10	4/17/08	0	<13
	4/17/08	3	**14**
	4/17/08	6	**18**
	4/17/08	9	**36**
	4/17/08	12	**27**

Sample ID	Sample Date	depth (inches)	Pb (ppm)
11	4/17/08	0	<13
	4/17/08	3	<14
	4/17/08	6	**47**
	4/17/08	9	<13
	4/17/08	12	<14
12	4/23/08	0	<12
	4/23/08	3	<13
	4/23/08	6	<13
	4/23/08	9	<13
	4/23/08	12	<12
13	4/17/08	0	**56**
	4/17/08	3	**56**
	4/17/08	6	**52**
	4/17/08	9	**34**
	4/17/08	12	**18**
16	4/19/08	0	**103**
	4/19/08	3	**154**
	4/19/08	6	**1,041**
17	4/20/08	0	**64**
	4/20/08	3	**53**
	4/20/08	6	**74**
	4/20/08	9	**53**
	4/20/08	12	**31**
18	4/20/08	0	**149**
	4/20/08	3	**310**
	4/20/08	6	**358**
	4/20/08	9	**42**
	4/20/08	12	**236**
19	4/23/08	0	<11
	4/23/08	3	<13
	4/23/08	6	<13
20	4/20/08	0	<12
	4/20/08	3	<13
	4/20/08	6	<13
	4/20/08	9	<12
	4/20/08	12	<13
21	4/20/08	0	<14
	4/20/08	3	<13
	4/20/08	6	**22**
	4/20/08	9	**17**
	4/20/08	12	**17**
22	4/20/08	0	**40**
	4/20/08	3	**54**
	4/20/08	6	**57**
	4/20/08	9	**94**
	4/20/08	12	**64**
23	4/20/08	0	<11
	4/20/08	3	<10
25	4/19/08	0	<14
	4/19/08	3	**14**
	4/19/08	6	<13
	4/19/08	9	<13
	4/19/08	12	<13

Sample ID	Sample Date	depth (inches)	Pb (ppm)
26	4/19/08	0	<13
	4/19/08	3	<12
	4/19/08	6	<13
	4/19/08	9	<12
	4/19/08	12	<13
28	4/19/08	0	<13
	4/19/08	3	<13
	4/19/08	6	<13
	4/19/08	9	<12
	4/19/08	12	<13
29	4/19/08	0	**47**
	4/19/08	3	**32**
30	4/19/08	0	<13
	4/19/08	3	<12
	4/19/08	6	<13
	4/19/08	9	<13
	4/19/08	12	<14
31	4/24/08	0	**40**
	4/24/08	3	**35**
	4/24/08	6	**19**
	4/24/08	9	<13
	4/24/08	12	<12
32	4/24/08	0	**41**
	4/24/08	3	<13
	4/24/08	6	<13
	4/24/08	9	<13
	4/24/08	12	<13
33	4/24/08	0	**19**
	4/24/08	3	<12
	4/24/08	6	<14
	4/24/08	9	<13
	4/24/08	12	<13
BUILDING 643 - Cable Building			
119	4/12/08	0	**27**
	4/12/08	3	**28**
	4/12/08	6	**27**
	4/12/08	9	**37**
	4/12/08	12	**29**
121	4/12/08	0	**32**
	4/12/08	3	**47**
	4/12/08	6	**53**
	4/12/08	9	**45**
123	4/12/08	0	**74**
	4/12/08	3	**42**
	4/12/08	6	**60**
	4/12/08	9	**98**
	4/12/08	12	**48**
124	4/12/08	0	**356**
	4/12/08	3	**251**
	4/12/08	6	**272**
	4/12/08	9	**183**
	4/12/08	12	**271**

Sample ID	Sample Date	depth (inches)	Pb (ppm)
125	4/12/08	0	**202**
	4/12/08	3	**153**
	4/12/08	6	**172**
	4/12/08	9	**450**
	4/12/08	12	**332**
128	4/12/08	0	**477**
	4/12/08	3	**1,062**
	4/12/08	6	**811**
	4/12/08	9	**67**
131	4/12/08	0	**1,314**
	4/12/08	3	**1,378**
	4/12/08	6	**1,288**
	4/12/08	9	**1,608**
133	4/12/08	0	**1,043**
	4/12/08	3	**1,090**
	4/12/08	6	**1,475**
	4/12/08	9	**1,378**
	4/12/08	12	**1,020**
134	4/12/08	0	**97**
	4/12/08	3	**126**
	4/12/08	6	**50**
	4/12/08	9	**59**
	4/12/08	12	**56**
137	4/12/08	0	**145**
	4/12/08	3	**160**
	4/12/08	6	**180**
	4/12/08	9	**154**
	4/12/08	12	**131**
138	4/12/08	0	**1,695**
	4/12/08	3	**901**
	4/12/08	6	**780**
	4/12/08	9	**942**
	4/12/08	12	**838**
141	4/12/08	0	**155**
	4/12/08	3	**156**
	4/12/08	6	**229**
	4/12/08	9	**253**
	4/12/08	12	**235**
1311	4/22/08	0	**395**
	4/22/08	6	**806**
	4/22/08	12	**45**
	4/22/08	18	<13
	4/22/08	24	<13
	4/22/08	30	<13
	4/22/08	36	<12
1331	4/22/08	0	**751**
	4/22/08	6	**563**
	4/22/08	12	**35**
	4/22/08	18	<13
	4/22/08	24	<13
	4/22/08	30	**20**
	4/22/08	36	**17**

Sample ID	Sample Date	depth (inches)	Pb (ppm)
1381	4/23/08	0	**291**
	4/23/08	6	**597**
	4/23/08	12	**653**
	4/23/08	18	**424**
	4/23/08	24	**123**
	4/23/08	30	<15
	4/23/08	36	**23**
BUILDING 259 - Midway Mall Complex			
188	4/13/08	0	**68**
	4/13/08	3	**202**
	4/13/08	6	**49**
	4/13/08	9	**39**
190	4/13/08	0	**74**
	4/13/08	3	**69**
	4/13/08	6	**354**
	4/13/08	9	**34**
	4/13/08	12	<13
191	4/13/08	0	**47**
	4/13/08	3	**72**
	4/13/08	6	**93**
	4/13/08	9	**43**
192	4/13/08	0	**280**
	4/13/08	3	**243**
	4/13/08	6	**15**
	4/13/08	9	**98**
	4/13/08	12	**74**
193	4/13/08	0	**126**
	4/13/08	3	**143**
	4/13/08	6	**169**
	4/13/08	9	**58**
	4/13/08	12	**56**
194	4/13/08	0	**108**
	4/13/08	3	**136**
	4/13/08	6	**193**
	4/13/08	9	**330**
	4/13/08	12	**124**
196	4/13/08	0	**115**
	4/13/08	3	**95**
	4/13/08	6	**119**
	4/13/08	9	**81**
	4/13/08	12	**101**
200	4/13/08	0	**158**
	4/13/08	3	**107**
202	4/13/08	0	**104**
	4/13/08	3	**166**
	4/13/08	6	**73**
	4/13/08	9	**17**
	4/13/08	12	<12
203	4/13/08	0	**36**
	4/13/08	3	**62**
	4/13/08	9	**98**
	4/13/08	12	**123**

Sample ID	Sample Date	depth (inches)	Pb (ppm)
204	4/13/08	0	**56**
	4/13/08	3	**93**
	4/13/08	6	**81**
	4/13/08	9	**68**
	4/13/08	12	**68**
205	4/13/08	0	**69**
	4/13/08	3	**76**
206	4/13/08	0	**23**
	4/13/08	3	**51**
	4/13/08	6	**25**
	4/13/08	9	**14**
207	4/13/08	0	**39**
	4/13/08	3	**15**
	4/13/08	6	<13
	4/13/08	9	<13
	4/13/08	12	<13
208	4/13/08	0	**68**
	4/13/08	3	**74**
	4/13/08	6	**70**
	4/13/08	9	**22**
209	4/13/08	0	**68**
	4/13/08	3	**83**
	4/13/08	6	**40**
	4/13/08	9	**15**
	4/13/08	12	<13
1921	4/13/08	0	**694**
	4/13/08	3	**421**
	4/13/08	6	**37**
	4/13/08	9	**130**
BUILDING 342 - Paint and Oil Storage			
243	4/18/08	0	**340**
	4/18/08	3	**135**
250	4/18/08	0	**902**
	4/18/08	3	**1,028**
	4/18/08	6	**1,239**
255	4/18/08	0	**236**
	4/18/08	3	**191**
	4/18/08	6	**154**
	4/18/08	9	**18**
	4/18/08	12	**24**
256	4/18/08	0	**338**
	4/18/08	3	**4,297**
	4/18/08	6	**2,787**
	4/18/08	9	**292**
264	4/18/08	0	**569**
	4/18/08	3	**733**
	4/18/08	6	**548**
	4/18/08	9	**251**
	4/18/08	12	**384**

Sample ID	Sample Date	depth (inches)	Pb (ppm)
267	4/18/08	0	**107**
	4/18/08	3	**123**
	4/18/08	6	**151**
	4/18/08	9	**209**
	4/18/08	12	**251**
269	4/18/08	0	**70**
	4/18/08	3	**178**
	4/18/08	6	**193**
	4/18/08	9	**129**
	4/18/08	12	**173**
2501	4/24/08	0	**190**
	4/24/08	6	**337**
	4/24/08	12	**416**
	4/24/08	18	**86**
	4/24/08	24	**<14**
	4/24/08	30	**15**
	4/24/08	36	**14**
BUILDING 357 - Machine Shop			
259	4/15/08	0	**334**
	4/15/08	3	**218**
262	4/15/08	0	**104**
	4/15/08	3	**155**
	4/15/08	6	**111**
	4/15/08	9	**37**
	4/15/08	12	**66**
268	4/15/08	0	**280**
	4/15/08	3	**52**
	4/15/08	6	**31**
	4/15/08	9	**32**
	4/15/08	12	**31**
272	4/15/08	0	**363**
	4/15/08	3	**656**
	4/15/08	6	**198**
	4/15/08	9	**185**
	4/15/08	12	**112**
275	4/15/08	0	**493**
	4/15/08	3	**227**
	4/15/08	6	**67**
	4/15/08	9	**77**
279	4/15/08	0	**471**
	4/15/08	3	**255**
	4/15/08	6	**350**
	4/15/08	9	**162**
	4/15/08	12	**50**
284	4/15/08	0	**700**
	4/15/08	3	**772**
	4/15/08	6	**472**
	4/15/08	9	**283**
	4/15/08	12	**99**
285	4/15/08	0	**440**
	4/15/08	3	**49**

Sample ID	Sample Date	depth (inches)	Pb (ppm)
287	4/15/08	0	**142**
	4/15/08	3	**58**
	4/15/08	6	**177**
	4/15/08	9	**143**
	4/15/08	12	**131**
291	4/15/08	0	**71**
	4/15/08	3	**41**
	4/15/08	6	**62**
	4/15/08	9	**59**
	4/15/08	12	**29**
BUILDING 353 - Carpentry Shop			
270	4/21/08	0	**70**
274	4/21/08	0	**165**
	4/21/08	3	**133**
281	4/21/08	0	**221**
	4/21/08	3	**357**
	4/21/08	6	**34**
	4/21/08	9	**228**
		12	**82**
282	4/21/08	0	**510**
	4/21/08	3	**408**
	4/21/08	6	**75**
	4/21/08	9	**132**
	4/21/08	12	**152**
286	4/21/08	0	**292**
	4/21/08	3	**171**
	4/21/08	6	**95**
	4/21/08	9	**48**
	4/21/08	12	**58**
288	4/21/08	0	**362**
	4/21/08	3	**263**
	4/21/08	6	**263**
289	4/21/08	0	**428**
	4/21/08	3	**369**
	4/21/08	6	**277**
293	4/21/08	0	**401**
	4/21/08	3	**484**
	4/21/08	6	**1,167**
	4/21/08	9	**291**
	4/21/08	12	**69**
BUILDING 5309 - Transmitter Building			
299	4/14/08	0	**154**
	4/14/08	3	**316**
	4/14/08	6	**86**
	4/14/08	9	**57**
	4/14/08	12	<13
300	4/14/08	0	**110**
301	4/14/08	0	**175**
	4/14/08	3	**66**
	4/14/08	6	**53**
	4/14/08	9	**23**
	4/14/08	12	**20**

Sample ID	Sample Date	depth (inches)	Pb (ppm)
303	4/14/08	0	**238**
	4/14/08	3	**90**
	4/14/08	6	**57**
	4/14/08	9	<13
	4/14/08	12	**17**
304	4/14/08	0	**56**
	4/14/08	3	**80**
	4/14/08	6	**34**
	4/14/08	9	**15**
	4/14/08	12	**33**
305	4/14/08	0	**33**
	4/14/08	3	**85**
	4/14/08	6	**55**
	4/14/08	9	**18**
	4/14/08	12	<13
307	4/14/08	0	**40**
	4/14/08	3	**19**
	4/14/08	6	**16**
	4/14/08	9	<13
	4/14/08	12	**14**
308	4/14/08	0	**25**
	4/14/08	3	**25**
	4/14/08	6	**27**
	4/14/08	9	**23**
	4/14/08	12	<14
309	4/14/08	0	**90**
	4/14/08	3	**58**
	4/14/08	6	**17**
	4/14/08	9	**78**
	4/14/08	12	**21**
310	4/14/08	0	**171**
	4/14/08	3	**115**
	4/14/08	6	**271**
	4/14/08	9	**2,852**
	4/14/08	12	**895**
3101	4/22/08	0	**138**
	4/22/08	6	**300**
	4/22/08	12	<13
	4/22/08	18	<13
	4/22/08	24	<13
	4/22/08	30	<13
BUILDING 578 - Marine barracks			
311	4/11/08	0	**16**
	4/11/08	3	**22**
	4/11/08	6	**30**
	4/11/08	9	**29**
	4/11/08	12	**27**

Sample ID	Sample Date	depth (inches)	Pb (ppm)
313	4/11/08	0	**48**
	4/11/08	3	**56**
	4/11/08	6	**52**
314	4/11/08	0	**49**
	4/11/08	3	**110**
	4/11/08	6	**69**
	4/11/08	9	**28**
317	4/11/08	0	**109**
	4/11/08	3	**57**
	4/11/08	6	**101**
	4/11/08	9	**251**
	4/11/08	12	**164**
318	4/11/08	0	**364**
	4/11/08	3	**590**
	4/11/08	6	**731**
	4/11/08	9	**704**
	4/11/08	12	**33**
321	4/11/08	0	**1,091**
323	4/11/08	0	**691**
	4/11/08	3	**221**
	4/11/08	6	**127**
	4/11/08	9	**49**
	4/11/08	12	**82**
324	4/11/08	0	**58**
	4/11/08	3	**35**
	4/11/08	6	**67**
	4/11/08	9	**61**
	4/11/08	12	**41**
328	4/11/08	0	**117**
	4/11/08	3	**147**
	4/11/08	6	**109**
	4/11/08	9	**158**
	4/11/08	12	**222**
329	4/11/08	0	**244**
	4/11/08	3	**673**
	4/11/08	6	**884**
	4/11/08	9	**274**
332	4/11/08	0	<13
	4/11/08	3	**18**
	4/11/08	6	<13
	4/11/08	9	<13
	4/11/08	12	<12
3181	4/23/08	0	**151**
	4/23/08	6	**1,209**
	4/23/08	12	**61**
	4/23/08	18	<14
	4/23/08	24	<13
	4/23/08	30	<14
	4/23/08	36	<13

Sample ID	Sample Date	depth (inches)	Pb (ppm)
BUILDING 414 - Midway House			
41401	4/23/08	0	**79**
	4/23/08	3	**47**
41402	4/23/08	0	<13
	4/23/08	3	**42**
41403	4/23/08	0	**148**
	4/23/08	3	**106**
41404	4/23/08	0	**159**
	4/23/08	3	**189**
41405	4/23/08	0	<14
	4/23/08	3	<15
41406	4/23/08	0	**115**
	4/23/08	3	**403**
BUILDING 416 - Historic Officers Quarters			
41601	4/23/08	0	**37**
	4/23/08	3	**32**
41602	4/23/08	0	**103**
	4/23/08	3	**280**
41603	4/23/08	0	**60**
	4/23/08	3	**86**
41604	4/23/08	0	**273**
	4/23/08	3	**48**
41605	4/23/08	0	<14
	4/23/08	3	<13
41606	4/23/08	0	**112**
	4/23/08	3	**67**
41607	4/23/08	0	**199**
	4/23/08	3	**280**
BUILDING 424 - Historic Officers Quarters			
42401	4/23/08	0	**41**
	4/23/08	3	**30**
42402	4/23/08	0	**96**
	4/23/08	3	**94**
42403	4/23/08	0	**77**
	4/23/08	3	**96**
42404	4/23/08	0	**18**
	4/23/08	3	<14
42405	4/23/08	0	**37**
	4/23/08	3	**29**
42406	4/23/08	0	**50**
	4/23/08	3	**70**
42407	4/23/08	0	**78**
	4/23/08	3	**58**
BUILDING 4203 - BOQ Bravo Barracks			
420301	4/23/08	0	**28**
	4/23/08	3	**24**
420302	4/23/08	0	**24**
	4/23/08	3	**22**
420303	4/23/08	0	**27**
	4/23/08	3	**35**
420304	4/23/08	0	**61**
	4/23/08	3	**60**
420305	4/23/08	0	**28**
	4/23/08	3	**41**

Sample ID	Sample Date	depth (inches)	Pb (ppm)
420306	4/23/08	0	**45**
	4/23/08	3	**39**
420307	4/23/08	0	**32**
	4/23/08	3	**28**
420308	4/23/08	0	**21**
	4/23/08	3	**28**
BUILDING 4210 - Concrete Duplex			
421001	4/23/08	0	**28**
	4/23/08	3	<13
421002	4/23/08	0	**41**
	4/23/08	3	**16**
421003	4/23/08	0	**23**
	4/23/08	3	<13
421004	4/23/08	0	**36**
	4/23/08	3	**21**
421005	4/23/08	0	**28**
	4/23/08	3	**19**
421006	4/23/08	0	**22**
	4/23/08	3	**38**

Notes:

XRF = X-Ray Fluorescence Testing

Bold = Analyte Detected

<13 = Results are less than the method reporting limit.

Table 2

Summary of Chemical Analytical Data
XRF Field Data and EPA Method 6010 Total Lead Results

2009 - U.S. Fish and Wildlife Ecological Risk Assessment
Midway Atoll National Wildlife Refuge

GeoEngineers Sample Number	FWS Field Sample Identification	Sample Location	XRF Result (ppm)	EPA 6010B Result (mg/kg)	Relative Percent Difference
0-50 ppm					
1	2-3	Reference	0	<10.1	--
2	3181-24	Marine Barracks	0	<10.2	--
3	5-3	Reference	3	**22.4**	-153%
4	2501-36	Paint & Oil Storage	**14**	**20.8**	-39%
5	307-6	Transmitter Building	**16**	**13.1**	20%
6	31-3	Reference	**35**	**27.1**	25%
7	1921-6	Midway Mall Complex	**37**	**68.0**	-59%
8	209-6	Midway Mall Complex	**40**	**56.2**	-34%
9	1311-12	Cable Building	**45**	**67.5**	-40%
10	188-6	Midway Mall Complex	**49**	**36.2**	30%
50-70 ppm					
11	9-0	Reference	**52**	**55.6**	-7%
12	17-3	Reference	**53**	**49.3**	7%
13	13-0	Reference	**56**	**87.5**	-44%
14	204-0	Midway Mall Complex	**56**	**84.8**	-41%
15	303-6	Transmitter Building	**57**	**50.8**	12%
16	B42407-3	Historical Office Quarters	**58**	**76.9**	-28%
17	17-0	Reference	**64**	**58.5**	9%
18	22-12	Reference	**64**	**77.7**	-19%
19	188-0	Midway Mall Complex	**68**	**63.7**	7%
20	208-0	Midway Mall Complex	**68**	**94.3**	-32%
70-100 ppm					
21	190-0	Midway Mall Complex	**74**	**76.9**	-4%
22	205-3	Midway Mall Complex	**76**	**73.1**	4%
23	B41401	Midway House	**79**	**165**	-70%
24	209-3	Midway Mall Complex	**83**	**81.2**	2%
25	305-3	Transmitter Building	**85**	**92.0**	-8%
26	2501-18	Paint & Oil Storage	**86**	**84.4**	2%
27	9-3	Reference	**89**	**67.2**	28%
28	22-9	Reference	**94**	**94.6**	-1%
29	B42403-3	Historical Office Quarters	**96**	**117**	-20%
30	203-9	Midway Mall Complex	**98**	**95.0**	3%
100-120 ppm					
31	317-6	Marine Barracks	**101**	**89.5**	12%
32	16-0	Reference	**103**	**107**	-4%
33	202-0	Midway Mall Complex	**104**	**98.8**	5%
34	300-0	Transmitter Building	**110**	**112**	-2%
35	314-3	Marine Barracks	**110**	**105**	5%
36	B41606	Historical Office Quarters	**112**	**253**	-77%
37	196-0	Midway Mall Complex	**115**	**116**	-1%
38	310-3	Transmitter Building	**115**	**164**	-35%
39	B41406	Midway House	**115**	**162**	-34%
40	328-0	Marine Barracks	**117**	**158**	-30%

GeoEngineers Sample Number	FWS Field Sample Identification	Sample Location	XRF Result (ppm)	EPA 6010B Result (mg/kg)	Relative Percent Difference
120-250 ppm					
41	323-6	Marine Barracks	**127**	**221**	-54%
42	18-0	Reference	**149**	**219**	-38%
43	200-0	Midway Mall Complex	**158**	**180**	-13%
44	B41404	Midway House	**159**	**152**	5%
45	317-12	Marine Barracks	**164**	**208**	-24%
46	202-3	Midway Mall Complex	**166**	**149**	11%
47	310-0	Transmitter Building	**171**	**180**	-5%
48	301-0	Transmitter Building	**175**	**189**	-8%
49	18-12	Reference	**236**	**74.2**	104%
50	303-0	Transmitter Building	**238**	**286**	-18%
>700 ppm					
51	318-6	Marine Barracks	**731**	**1,500**	-69%
52	1331-0	Cable Building	**751**	**613**	20%
53	1311-6	Cable Building	**806**	**1,900**	-81%
54	329-6	Marine Barracks	**884**	**868**	2%
55	16-6	Reference	**1,041**	**1,090**	-5%
56	3181-6	Marine Barracks	**1209**	**948**	24%

Notes:

Bold = Analyte Detected

<10 = Results are less than the method reporting limit.

ppm = parts per million

mg/kg = milligrams per kilograms

FWS = Fish and Wildlife Services

Table 3

Summary of Chemical Analytical Data
Total Lead in Soil Results

Midway Atoll National Wildlife Refuge

Parameter		Lead
Units		mg/kg
Sample Identification	Sample Date	Value
BACKGROUND		
BACKGROUND 01 0-6IN	6/13/2010	<5.2
BACKGROUND 01 12-18IN	6/13/2010	<5.2
BACKGROUND 01 24-28IN	6/13/2010	<4.9
BACKGROUND 01 30-36IN	6/13/2010	<5.0
BACKGROUND 02 0-6IN	6/13/2010	**5**
BACKGROUND 02 12-18IN	6/13/2010	<5.2
BACKGROUND 02 24-28IN	6/13/2010	<5.3
BACKGROUND 02 30-36IN	6/13/2010	**6.4**
BACKGROUND 03 0-6IN	6/13/2010	<5.3
BACKGROUND 03 12-18IN	6/13/2010	<5.4
BACKGROUND 03 24-28IN	6/13/2010	<4.6
BACKGROUND 03 30-36IN	6/13/2010	<5.1
DUPLICATE 16 30-36IN	6/13/2010	<5.0
BACKGROUND 04 0-6IN	6/13/2010	<5.4
BACKGROUND 04 12-18IN	6/13/2010	<5.1
BACKGROUND 04 24-28IN	6/13/2010	<5.0
BACKGROUND 04 30-36IN	6/13/2010	<5.1
BACKGROUND 05 0-6IN	6/13/2010	**25**
BACKGROUND 05 12-18IN	6/13/2010	**15**
BACKGROUND 05 24-28IN	6/13/2010	<4.7
BACKGROUND 05 30-36IN	6/13/2010	<4.9
BACKGROUND 06 0-6IN	6/13/2010	<2.7
DUPLICATE 18 0-6IN	6/13/2010	**5.6**
BACKGROUND 06 12-18IN	6/13/2010	<2.7
BACKGROUND 06 24-28IN	6/13/2010	<5.4
BACKGROUND 06 30-36IN	6/13/2010	<2.6
BACKGROUND 07 0-6IN	6/13/2010	<2.5
BACKGROUND 07 12-18IN	6/13/2010	<2.7
BACKGROUND 07 24-28IN	6/13/2010	<5.1
BACKGROUND 07 30-36IN	6/13/2010	<5.0
BACKGROUND 08 0-6IN	6/13/2010	<4.8
BACKGROUND 08 12-18IN	6/13/2010	<5.2
BACKGROUND 08 24-28IN	6/13/2010	<5.2
BACKGROUND 08 30-36IN	6/13/2010	<5.4
BACKGROUND 09 0-6IN	6/13/2010	<2.7
BACKGROUND 09 12-18IN	6/13/2010	<2.6
BACKGROUND 09 24-28IN	6/13/2010	<2.7

Parameter		Lead
Units		mg/kg
Sample Identification	Sample Date	Value
BACKGROUND 09 30-36IN	6/13/2010	<2.4
BACKGROUND 10 0-6IN	6/13/2010	<5.1
BACKGROUND 10 12-18IN	6/13/2010	<5.4
BACKGROUND 10 24-28IN	6/13/2010	<2.6
BACKGROUND 10 30-36IN	6/13/2010	<5.1
BACKGROUND 11 0-6IN	6/13/2010	<5.4
BACKGROUND 11 12-18IN	6/13/2010	<2.4
DUPLICATE 15 12-18IN	6/13/2010	<2.4
BACKGROUND 11 24-28IN	6/13/2010	<5.1
BACKGROUND 11 30-36IN	6/13/2010	<5.3
BACKGROUND 12 0-6IN	6/13/2010	<2.7
BACKGROUND 12 12-18IN	6/13/2010	<2.7
BACKGROUND 12 24-28IN	6/13/2010	<4.6
BACKGROUND 12 30-36IN	6/13/2010	<2.7
BACKGROUND 13 0-6IN	6/13/2010	<5.0
BACKGROUND 13 12-18IN	6/13/2010	<4.8
BACKGROUND 13 24-28IN	6/13/2010	<2.6
BACKGROUND 13 30-36IN	6/13/2010	<2.5
BACKGROUND 14 0-6IN	6/13/2010	<4.6
BACKGROUND 14 12-18IN	6/13/2010	<5.0
BACKGROUND 14 24-28IN	6/13/2010	<4.9
BACKGROUND 14 30-36IN	6/13/2010	<4.7
BACKGROUND 15 0-6IN	6/13/2010	**140**
BACKGROUND 15 12-18IN	6/13/2010	**52**
BACKGROUND 15 24-28IN	6/13/2010	**45**
BACKGROUND 15 30-36IN	6/13/2010	**16**
BACKGROUND 16 0-6IN	6/13/2010	**250**
BACKGROUND 16 12-18IN	6/13/2010	**930**
BACKGROUND 16 24-28IN	6/13/2010	**220**
BACKGROUND 16 30-36IN	6/13/2010	<4.8
BACKGROUND 17 0-6IN	6/13/2010	<4.9
BACKGROUND 17 12-18IN	6/13/2010	<4.6
BACKGROUND 17 24-28IN	6/13/2010	<4.6
BACKGROUND 17 30-36IN	6/13/2010	<4.8
BACKGROUND 18 0-6IN	6/13/2010	<5.2
BACKGROUND 18 12-18IN	6/13/2010	<4.7
BACKGROUND 18 24-28IN	6/13/2010	<5.6
BACKGROUND 18 30-36IN	6/13/2010	<5.0
BACKGROUND 19 0-6IN	6/13/2010	<2.7
BACKGROUND 19 12-18IN	6/13/2010	<2.6
BACKGROUND 19 24-28IN	6/13/2010	<2.5
BACKGROUND 19 30-36IN	6/13/2010	<2.6
BACKGROUND 20 0-6IN	6/13/2010	<5.3

Parameter		Lead
Units		mg/kg
Sample Identification	Sample Date	Value
BACKGROUND 20 12-18IN	6/13/2010	<5.2
BACKGROUND 20 24-28IN	6/13/2010	<5.1
DUPLICATE 17 28-28IN	6/13/2010	<4.8
BACKGROUND 20 30-36IN	6/13/2010	<4.6
BUILDING 363		
BUILDING 363 01 0-6IN	6/12/2010	**1,000**
BUILDING 363 01 12-18IN	6/12/2010	**60**
DUPLICATE 05 12-18IN	6/11/2010	**43**
BUILDING 363 01 24-28IN	6/12/2010	**30**
BUILDING 363 02 0-6IN	6/12/2010	**130**
BUILDING 363 02 12-18IN	6/12/2010	**23**
DUPLICATE 06 12-18IN	6/12/2010	**31**
BUILDING 363 02 24-28IN	6/12/2010	**46**
BUILDING 363 03 0-6IN	6/12/2010	**83**
BUILDING 363 03 12-18IN	6/12/2010	**63**
BUILDING 363 03 24-28IN	6/12/2010	**79**
BUILDING 363 03 30-36IN	6/12/2010	**17**
BUILDING 363 04 0-6IN	6/12/2010	**980**
DUPLICATE 07 0-6IN	6/12/2010	**790**
BUILDING 363 04 12-18IN	6/12/2010	**490**
BUILDING 363 04 24-28IN	6/12/2010	**180**
BUILDING 363 05 0-6IN	6/12/2010	**430**
BUILDING 363 05 12-18IN	6/12/2010	**180**
BUILDING 363 05 24-28IN	6/12/2010	**260**
BUILDING 363 06 0-6IN	6/12/2010	**85**
BUILDING 363 06 12-18IN	6/12/2010	**43**
BUILDING 363 06 24-28IN	6/12/2010	**16**
BUILDING 363 07 0-6IN	6/12/2010	**110**
BUILDING 363 07 12-18IN	6/12/2010	**38**
BUILDING 363 07 24-28IN	6/12/2010	<2.7
BUILDING 363 07 30-36IN	6/12/2010	**110**
BUILDING 363 08 0-6IN	6/12/2010	**610**
BUILDING 363 09 0-6IN	6/12/2010	**370**
BUILDING 363 10 0-6IN	6/12/2010	**210**
BUILDING 363 11 0-6IN	6/12/2010	**180**
BUILDING 363 11 12-18IN	6/12/2010	**130**
BUILDING 363 11 24-28IN	6/12/2010	**160**
BUILDING 363 12 0-6IN	6/12/2010	**9,300**
BUILDING 363 12 12-18IN	6/12/2010	**130**
BUILDING 363 12 24-28IN	6/12/2010	**120**
BUILDING 363 13 0-6IN	6/12/2010	**240**
BUILDING 363 13 12-18IN	6/12/2010	**120**
BUILDING 363 13 24-28IN	6/12/2010	**110**

Parameter		Lead
Units		mg/kg
Sample Identification	Sample Date	Value
BUILDING 363 14 0-6IN	6/12/2010	**260**
BUILDING 363 14 12-18IN	6/12/2010	**160**
BUILDING 363 14 24-28IN	6/12/2010	**150**
BUILDING 363 15 0-6IN	6/12/2010	**560**
BUILDING 363 15 12-18IN	6/12/2010	**220**
BUILDING 363 16 0-6IN	6/12/2010	**330**
BUILDING 363 16 12-18IN	6/12/2010	**160**
BUILDING 363 16 24-28IN	6/12/2010	**120**
BUILDING 421		
BUILDING 421 01 0-6IN	6/14/2010	**140**
BUILDING 421 01 12-18IN	6/14/2010	**28**
DUPLICATE 21 12-18IN	6/14/2010	**42**
BUILDING 421 01 24-28IN	6/14/2010	<5.0
BUILDING 421 01 30-36IN	6/14/2010	<5.1
BUILDING 421 02 0-6IN	6/14/2010	**120**
BUILDING 421 02 12-18IN	6/14/2010	<2.4
BUILDING 421 02 24-28IN	6/14/2010	<4.9
BUILDING 421 03 0-6IN	6/14/2010	**95**
BUILDING 421 03 12-18IN	6/14/2010	**44**
BUILDING 421 03 24-28IN	6/14/2010	<4.7
BUILDING 421 04 0-6IN	6/14/2010	**35**
BUILDING 421 04 12-18IN	6/14/2010	<5.1
BUILDING 421 04 24-28IN	6/14/2010	<4.9
BUILDING 421 05 0-6IN	6/14/2010	**28**
DUPLICATE 22 0-6IN	6/14/2010	**29**
BUILDING 421 05 12-18IN	6/14/2010	**160**
BUILDING 421 05 24-28IN	6/14/2010	<2.4
BUILDING 421 06 0-6IN	6/14/2010	**250**
BUILDING 421 06 12-18IN	6/14/2010	**48**
BUILDING 421 06 24-28IN	6/14/2010	<2.5
BUILDING 421 06 30-36IN	6/14/2010	<2.6
BUILDING 421 07 0-6IN	6/14/2010	**39**
BUILDING 421 07 12-18IN	6/14/2010	<4.9
BUILDING 421 07 24-28IN	6/14/2010	<5.0
BUILDING 421 08 0-6IN	6/14/2010	**20**
BUILDING 421 08 12-18IN	6/14/2010	**11**
BUILDING 421 08 24-28IN	6/14/2010	<4.7
BUILDING 421 09 0-6IN	6/14/2010	**47**
BUILDING 421 09 12-18IN	6/14/2010	<2.6
BUILDING 421 09 24-28IN	6/14/2010	<4.9
BUILDING 421 10 0-6IN	6/14/2010	**27**
BUILDING 421 10 12-18IN	6/14/2010	<4.8
BUILDING 421 10 24-28IN	6/14/2010	<4.6

Parameter		Lead
Units		mg/kg
Sample Identification	Sample Date	Value
BUILDING 421 11 0-6IN	6/14/2010	**29**
BUILDING 421 11 12-18IN	6/14/2010	<2.4
BUILDING 421 11 24-28IN	6/14/2010	<4.9
DUPLICATE 24 24-28IN	6/14/2010	<5.0
BUILDING 421 12 0-6IN	6/14/2010	**25**
BUILDING 421 12 12-18IN	6/14/2010	<2.4
BUILDING 421 12 24-28IN	6/14/2010	<5.0
BUILDING 421 13 0-6IN	6/14/2010	**13**
BUILDING 421 13 12-18IN	6/14/2010	**16**
BUILDING 421 13 24-28IN	6/14/2010	**11**
BUILDING 421 14 0-6IN	6/14/2010	**2.8**
BUILDING 421 14 12-18IN	6/14/2010	**4.8**
BUILDING 421 14 24-28IN	6/14/2010	<0.5
BUILDING 421 15 0-6IN	6/14/2010	**32**
BUILDING 421 15 12-18IN	6/14/2010	**3.9**
BUILDING 421 15 24-28IN	6/14/2010	<2.5
BUILDING 421 16 0-6IN	6/14/2010	**380**
BUILDING 421 16 12-18IN	6/14/2010	**130**
BUILDING 421 16 24-28IN	6/14/2010	<4.9
BUILDING 421 17 0-6IN	6/14/2010	**66**
BUILDING 421 17 12-18IN	6/14/2010	<2.6
BUILDING 421 17 24-28IN	6/14/2010	<5.0
BUILDING 421 18 0-6IN	6/14/2010	**100**
BUILDING 421 18 12-18IN	6/14/2010	<2.6
BUILDING 421 18 24-28IN	6/14/2010	<5.1
BUILDING 421 19 0-6IN	6/14/2010	**540**
BUILDING 421 19 12-18IN	6/14/2010	<2.5
BUILDING 421 19 24-28IN	6/14/2010	<4.9
BUILDING 623		
BUILDING 623 1 0-6IN	6/14/2010	**670**
BUILDING 623 1 12-18IN	6/14/2010	**280**
BUILDING 623 1 24-28IN	6/14/2010	**130**
BUILDING 623 1 30-36IN	6/14/2010	**270**
BUILDING 623 2 0-6IN	6/14/2010	**700**
BUILDING 623 2 12-18IN	6/14/2010	**550**
BUILDING 623 2 24-28IN	6/14/2010	**140**
BUILDING 623 3 0-6IN	6/14/2010	**350**
BUILDING 623 3 12-18IN	6/14/2010	**250**
BUILDING 623 3 24-28IN	6/14/2010	**170**
BUILDING 623 4 0-6IN	6/14/2010	**190**
BUILDING 623 4 12-18IN	6/14/2010	**190**
BUILDING 623 4 24-28IN	6/14/2010	**210**
BUILDING 623 5 0-6IN	6/14/2010	**140**

Parameter		Lead
Units		mg/kg
Sample Identification	Sample Date	Value
BUILDING 623 5 12-18IN	6/14/2010	**140**
BUILDING 623 5 24-28IN	6/14/2010	**120**
BUILDING 623 6 0-6IN	6/14/2010	**460**
BUILDING 623 6 12-18IN	6/14/2010	**200**
BUILDING 623 6 24-28IN	6/14/2010	**99**
BUILDING 623 6 30-36IN	6/14/2010	**100**
DUPLICATE 51 30-36IN	6/14/2010	<25
BUILDING 623 7 0-6IN	6/14/2010	**680**
BUILDING 623 7 12-18IN	6/14/2010	**210**
BUILDING 623 7 24-28IN	6/14/2010	**120**
BUILDING 623 8 0-6IN	6/14/2010	**210**
BUILDING 623 8 12-18IN	6/14/2010	**160**
BUILDING 623 9 0-6IN	6/14/2010	**430**
BUILDING 623 9 12-18IN	6/14/2010	**400**
BUILDING 623 10 0-6IN	6/14/2010	**390**
BUILDING 623 10 12-18IN	6/14/2010	**170**
DUPLICATE 23 12-18IN	6/14/2010	**70**
BUILDING 623 10 24-28IN	6/14/2010	**140**
BUILDING 623 11 0-6IN	6/14/2010	**1,100**
BUILDING 623 11 12-18IN	6/14/2010	**150**
BUILDING 623 11 24-28IN	6/14/2010	**110**
BUILDING 623 12 0-6IN	6/14/2010	**220**
BUILDING 623 12 12-18IN	6/14/2010	**78**
BUILDING 623 12 24-28IN	6/14/2010	**11**
BUILDING 623 13 0-6IN	6/15/2010	**340**
BUILDING 623 13 12-18IN	6/15/2010	**45**
BUILDING 623 13 24-28IN	6/15/2010	**22**
BUILDING 623 14 0-6IN	6/15/2010	**430**
BUILDING 623 14 12-18IN	6/15/2010	<2.5
BUILDING 623 14 24-28IN	6/15/2010	<2.5
BUILDING 623 15 0-6IN	6/15/2010	**99**
BUILDING 623 15 12-18IN	6/15/2010	**12**
BUILDING 623 15 24-28IN	6/15/2010	<2.7
BUILDING 623 16 0-6IN	6/15/2010	**550**
BUILDING 623 16 12-18IN	6/15/2010	**83**
BUILDING 623 16 24-28IN	6/15/2010	<2.5
BUILDING 623 17 0-6IN	6/15/2010	**60**
BUILDING 623 17 12-18IN	6/15/2010	**78**
BUILDING 623 17 24-28IN	6/15/2010	**18**
BUILDING 623 18 0-6IN	6/15/2010	**160**
BUILDING 623 18 12-18IN	6/15/2010	**120**
BUILDING 623 18 24-28IN	6/15/2010	**110**
BUILDING 623 19 0-6IN	6/15/2010	**550**

Parameter		Lead
Units		mg/kg
Sample Identification	Sample Date	Value
BUILDING 623 19 12-18IN	6/15/2010	**160**
BUILDING 623 19 24-28IN	6/15/2010	**110**
BUILDING 623 20 0-6IN	6/14/2010	**140**
BUILDING 623 20 12-18IN	6/14/2010	**130**
BUILDING 623 20 24-28IN	6/14/2010	**300**
DUPLICATE 25 24-28IN	6/15/2010	**57**
BUILDING 623 21 0-6IN	6/14/2010	**210**
BUILDING 623 21 12-18IN	6/14/2010	**230**
BUILDING 623 21 24-28IN	6/14/2010	**120**
BUILDING 1124		
BUILDING 1124 01 0-6IN	6/12/2010	**21**
BUILDING 1124 01 12-18IN	6/12/2010	**17**
BUILDING 1124 01 24-28IN	6/12/2010	<2.6
DUPLICATE 08 24-28IN	6/12/2010	**18**
BUILDING 1124 02 0-6IN	6/12/2010	**42**
BUILDING 1124 02 12-18IN	6/12/2010	**57**
BUILDING 1124 02 24-28IN	6/12/2010	**120**
BUILDING 1124 02 30-36IN	6/12/2010	**54**
BUILDING 1124 03 0-6IN	6/12/2010	**36**
BUILDING 1124 03 12-18IN	6/12/2010	**51**
BUILDING 1124 03 24-28IN	6/12/2010	**32**
BUILDING 1124 04 0-6IN	6/12/2010	**3.3**
DUPLICATE 09 0-6IN	6/12/2010	**12**
BUILDING 1124 04 12-18IN	6/12/2010	**4.2**
BUILDING 1124 05 0-6IN	6/12/2010	**9.7**
BUILDING 1124 05 12-18IN	6/12/2010	<2.5
BUILDING 1124 05 24-28IN	6/12/2010	<2.4
BUILDING 1124 06 0-6IN	6/12/2010	**13**
BUILDING 1124 06 12-18IN	6/12/2010	**39**
BUILDING 1124 06 24-28IN	6/12/2010	**6.8**
BUILDING 1124 07 0-6IN	6/12/2010	**40**
DUPLICATE 10 0-6IN	6/12/2010	**49**
BUILDING 1124 07 12-18IN	6/12/2010	<2.4
BUILDING 1124 07 24-28IN	6/12/2010	<5.0
BUILDING 1124 07 30-36IN	6/12/2010	<4.8
BUILDING 1124 08 0-6IN	6/12/2010	**30**
BUILDING 1124 08 12-18IN	6/12/2010	**18**
BUILDING 1124 08 24-28IN	6/12/2010	**12**
BUILDING 1124 09 0-6IN	6/12/2010	**3.6**
BUILDING 1124 09 12-18IN	6/12/2010	**5**
BUILDING 1124 09 24-28IN	6/12/2010	<4.7
BUILDING 1124 10 0-6IN	6/12/2010	**14**
BUILDING 1124 10 12-18IN	6/12/2010	**17**

Parameter		Lead
Units		mg/kg
Sample Identification	Sample Date	Value
BUILDING 1124 10 24-28IN	6/12/2010	<2.4
BUILDING 1124 11 0-6IN	6/12/2010	**42**
BUILDING 1124 11 12-18IN	6/12/2010	**3.1**
BUILDING 1124 11 24-28IN	6/12/2010	<2.6
BUILDING 1124 13 0-6IN	6/12/2010	**49**
BUILDING 1124 13 12-18IN	6/12/2010	**25**
BUILDING 1124 13 24-28IN	6/12/2010	**27**
BUILDING 1124 14 0-6IN	6/12/2010	**20**
BUILDING 1124 14 12-18IN	6/12/2010	**11**
BUILDING 1124 14 24-28IN	6/12/2010	**5.8**
BUILDING 1124 15 0-6IN	6/12/2010	**45**
BUILDING 1124 15 12-18IN	6/12/2010	**53**
BUILDING 1124 15 24-28IN	6/12/2010	<5.3
BUILDING 1124 16 0-6IN	6/12/2010	**12**
BUILDING 1124 16 12-18IN	6/12/2010	**7.9**
BUILDING 1124 17 0-6IN	6/12/2010	**14**
BUILDING 1124 17 12-18IN	6/12/2010	<5.0
BUILDING 1124 17 24-28IN	6/12/2010	<4.6
BUILDING 1124 18 0-6IN	6/12/2010	<2.3
BUILDING 1124 18 12-18IN	6/12/2010	<2.3
BUILDING 1124 18 24-28IN	6/12/2010	<5.0
BUILDING 2403		
BUILDING 2403 01 0-6IN	6/14/2010	**48**
DUPLICATE 26 0-6IN	6/15/2010	**50**
BUILDING 2403 01 12-18IN	6/14/2010	<2.6
DUPLICATE 27 12-18IN	6/15/2010	**40**
BUILDING 2403 01 24-28IN	6/14/2010	<2.4
BUILDING 2403 02 0-6IN	6/14/2010	**42**
BUILDING 2403 02 12-18IN	6/14/2010	**23**
BUILDING 2403 02 24-28IN	6/14/2010	<5.1
BUILDING 2403 02 30-36IN	6/14/2010	<2.5
BUILDING 2403 03 0-6IN	6/14/2010	**140**
BUILDING 2403 03 12-18IN	6/14/2010	**230**
BUILDING 2403 03 24-28IN	6/14/2010	<5.0
BUILDING 2403 04 0-6IN	6/14/2010	**2.6**
BUILDING 2403 04 12-18IN	6/14/2010	<2.5
BUILDING 2403 04 24-28IN	6/14/2010	<5.0
BUILDING 2403 05 0-6IN	6/14/2010	**17**
BUILDING 2403 05 12-18IN	6/14/2010	**9.6**
BUILDING 2403 05 24-28IN	6/14/2010	**8.2**
BUILDING 2403 06 0-6IN	6/14/2010	**14**
BUILDING 2403 06 12-18IN	6/14/2010	<2.5
BUILDING 2403 06 24-28IN	6/14/2010	<2.5

Parameter		Lead
Units		mg/kg
Sample Identification	Sample Date	Value
BUILDING 2403 07 0-6IN	6/14/2010	**2.9**
BUILDING 2403 07 12-18IN	6/14/2010	<2.5
BUILDING 2403 07 24-28IN	6/14/2010	<5.0
BUILDING 2403 08 0-6IN	6/14/2010	**15**
BUILDING 2403 08 12-18IN	6/14/2010	<2.5
BUILDING 2403 08 24-28IN	6/14/2010	<5.2
BUILDING 2403 09 0-6IN	6/14/2010	**160**
BUILDING 2403 09 12-18IN	6/14/2010	<2.7
BUILDING 2403 09 24-28IN	6/14/2010	<2.5
BUILDING 2403 10 0-6IN	6/14/2010	**50**
BUILDING 2403 10 12-18IN	6/14/2010	<2.6
BUILDING 2403 10 24-28IN	6/14/2010	**100**
BUILDING 2403 11 0-6IN	6/14/2010	**140**
BUILDING 2403 11 12-18IN	6/14/2010	**100**
BUILDING 2403 11 24-28IN	6/14/2010	**120**
BUILDING 2403 12 0-6IN	6/14/2010	**120**
BUILDING 2403 12 12-18IN	6/14/2010	**120**
BUILDING 2403 12 24-28IN	6/14/2010	**170**
BUILDING 2403 13 0-6IN	6/14/2010	**150**
BUILDING 2403 13 12-18IN	6/14/2010	**100**
BUILDING 2403 13 24-28IN	6/14/2010	**110**
BUILDING 2403 14 0-6IN	6/14/2010	**150**
BUILDING 2403 14 12-18IN	6/14/2010	**100**
BUILDING 2403 14 24-28IN	6/14/2010	**110**
BUILDING 2403 15 0-6IN	6/14/2010	**130**
BUILDING 2403 15 12-18IN	6/14/2010	**120**
BUILDING 2403 15 24-28IN	6/14/2010	**120**
BUILDING 2403 16 0-6IN	6/14/2010	**120**
BUILDING 2403 16 12-18IN	6/14/2010	**100**
BUILDING 2403 16 24-28IN	6/14/2010	**230**
BUILDING 2403 17 0-6IN	6/14/2010	**240**
BUILDING 2403 18 0-6IN	6/14/2010	**150**
BUILDING 2403 19 0-6IN	6/14/2010	**160**
BUILDING 2403 20 0-6IN	6/14/2010	**160**
BUILDING 2403 20 12-18IN	6/14/2010	**120**
BUILDING 2403 20 24-28IN	6/14/2010	**120**
BUILDING 2403 20 30-36IN	6/14/2010	**110**
BUILDING 2403 21 0-6IN	6/14/2010	**180**
BUILDING 2403 21 12-18IN	6/14/2010	**110**
BUILDING 2403 21 24-28IN	6/14/2010	**120**
BUILDING 3504		
BUILDING 3504 01 0-6IN	6/12/2010	**28**
DUPLICATE 11 0-6IN	6/12/2010	**24**

Parameter		Lead
Units		mg/kg
Sample Identification	Sample Date	Value
BUILDING 3504 01 12-18IN	6/12/2010	**34**
BUILDING 3504 01 24-28IN	6/12/2010	<2.4
BUILDING 3504 01 30-36IN	6/12/2010	<2.5
BUILDING 3504 02 0-6IN	6/12/2010	**91**
BUILDING 3504 02 12-18IN	6/12/2010	**18**
BUILDING 3504 02 24-28IN	6/12/2010	**4.8**
BUILDING 3504 03 0-6IN	6/12/2010	**56**
BUILDING 3504 03 12-18IN	6/12/2010	**1.8**
BUILDING 3504 03 24-28IN	6/12/2010	**1.6**
BUILDING 3504 04 0-6IN	6/12/2010	**39**
BUILDING 3504 04 12-18IN	6/12/2010	**7.8**
BUILDING 3504 05 0-6IN	6/12/2010	**40**
BUILDING 3504 05 12-18IN	6/12/2010	**14**
BUILDING 3504 05 24-28IN	6/12/2010	**12**
BUILDING 3504 06 0-6IN	6/12/2010	**35**
BUILDING 3504 06 12-18IN	6/12/2010	**100**
BUILDING 3504 06 24-28IN	6/12/2010	**100**
BUILDING 3504 07 0-6IN	6/12/2010	**98**
BUILDING 3504 07 12-18IN	6/12/2010	**110**
BUILDING 3504 08 0-6IN	6/12/2010	**140**
BUILDING 3504 08 12-18IN	6/12/2010	**110**
BUILDING 3504 08 24-28IN	6/12/2010	**180**
BUILDING 3504 08 30-36IN	6/12/2010	**98**
BUILDING 3504 09 0-6IN	6/12/2010	**120**
BUILDING 3504 09 12-18IN	6/12/2010	**120**
DUPLICATE 12 12-18IN	6/12/2010	**37**
BUILDING 3504 09 24-28IN	6/12/2010	**110**
BUILDING 3504 10 0-6IN	6/12/2010	**110**
BUILDING 3504 10 12-18IN	6/12/2010	**110**
BUILDING 3504 10 24-28IN	6/12/2010	**89**
BUILDING 3504 11 0-6IN	6/12/2010	**100**
BUILDING 3504 11 12-18IN	6/12/2010	**90**
BUILDING 3504 11 24-28IN	6/12/2010	**100**
BUILDING 3504 12 0-6IN	6/12/2010	**87**
BUILDING 3504 12 12-18IN	6/12/2010	**140**
BUILDING 3504 12 24-28IN	6/12/2010	**97**
BUILDING 3504 13 0-6IN	6/13/2010	**78**
BUILDING 3504 13 12-18IN	6/13/2010	<2.4
DUPLICATE 13 12-18IN	6/13/2010	**10**
BUILDING 3504 13 24-28IN	6/13/2010	**15**
BUILDING 3504 13 30-36IN	6/13/2010	**20**
BUILDING 3504 14 0-6IN	6/13/2010	**42**
BUILDING 3504 14 12-18IN	6/13/2010	**5.7**

Parameter		Lead
Units		mg/kg
Sample Identification	Sample Date	Value
BUILDING 3504 14 24-28IN	6/13/2010	**8.4**
BUILDING 3504 15 0-6IN	6/13/2010	**52**
BUILDING 3504 15 12-18IN	6/13/2010	**8.5**
BUILDING 3504 15 24-28IN	6/13/2010	**5.9**
BUILDING 3504 16 0-6IN	6/13/2010	**40**
BUILDING 3504 16 12-18IN	6/13/2010	<2.6
BUILDING 3504 16 24-28IN	6/13/2010	**18**
BUILDING 3504 17 0-6IN	6/13/2010	**38**
BUILDING 3504 17 12-18IN	6/13/2010	**21**
BUILDING 3504 17 24-28IN	6/13/2010	<2.4
BUILDING 3504 18 0-6IN	6/13/2010	**15**
BUILDING 3504 18 12-18IN	6/13/2010	<5.0
BUILDING 3504 18 24-28IN	6/13/2010	<4.7
BUILDING 3504 19 0-6IN	6/13/2010	**9.4**
BUILDING 3504 19 12-18IN	6/13/2010	<5.0
BUILDING 3504 19 24-28IN	6/13/2010	<2.5
BUILDING 3504 20 0-6IN	6/13/2010	**5.2**
BUILDING 3504 20 12-18IN	6/13/2010	<2.5
BUILDING 3504 20 24-28IN	6/13/2010	<2.3
BUILDING 3504 21 0-6IN	6/13/2010	<2.5
BUILDING 3504 21 12-18IN	6/13/2010	**22**
BUILDING 3504 21 24-28IN	6/13/2010	<2.5
BUILDING 3504 22 0-6IN	6/13/2010	<2.7
BUILDING 3504 22 12-18IN	6/13/2010	**26**
BUILDING 3504 22 24-28IN	6/13/2010	<2.8
BUILDING 3504 23 0-6IN	6/13/2010	<2.8
BUILDING 3504 23 12-18IN	6/13/2010	**45**
BUILDING 3504 23 24-28IN	6/13/2010	<2.5
BUILDING 3512		
BUILDING 3512 01 0-6IN	6/14/2010	**87**
BUILDING 3512 01 12-18IN	6/14/2010	<2.6
BUILDING 3512 01 24-28IN	6/14/2010	**8.6**
DUPLICATE 14 24-28IN	6/13/2010	**5.7**
BUILDING 3512 01 30-36IN	6/14/2010	<2.5
BUILDING 3512 02 0-6IN	6/14/2010	**210**
BUILDING 3512 02 12-18IN	6/14/2010	**210**
BUILDING 3512 02 24-28IN	6/14/2010	**410**
BUILDING 3512 03 0-6IN	6/14/2010	**27**
BUILDING 3512 03 12-18IN	6/14/2010	**17**
BUILDING 3512 03 24-28IN	6/14/2010	**5.2**
BUILDING 3512 04 0-6IN	6/14/2010	**23**
BUILDING 3512 04 12-18IN	6/14/2010	<2.5
BUILDING 3512 04 24-28IN	6/14/2010	<24

Parameter		Lead
Units		mg/kg
Sample Identification	Sample Date	Value
BUILDING 3512 05 0-6IN	6/14/2010	**76**
BUILDING 3512 05 12-18IN	6/14/2010	**16**
BUILDING 3512 05 24-28IN	6/14/2010	<4.9
BUILDING 3512 06 0-6IN	6/14/2010	**58**
BUILDING 3512 06 12-18IN	6/14/2010	**17**
BUILDING 3512 06 24-28IN	6/14/2010	<4.9
BUILDING 3512 07 0-6IN	6/14/2010	**36**
BUILDING 3512 07 12-18IN	6/14/2010	<5.2
BUILDING 3512 07 24-28IN	6/14/2010	<5.1
BUILDING 3512 08 0-6IN	6/14/2010	**35**
BUILDING 3512 08 12-18IN	6/14/2010	<2.4
DUPLICATE 19 12-18IN	6/14/2010	<2.6
BUILDING 3512 08 24-28IN	6/14/2010	<2.4
BUILDING 3512 09 0-6IN	6/14/2010	**13**
BUILDING 3512 09 12-18IN	6/14/2010	**4.9**
BUILDING 3512 09 24-28IN	6/14/2010	**12**
BUILDING 3512 10 0-6IN	6/14/2010	**17**
BUILDING 3512 10 12-18IN	6/14/2010	**21**
BUILDING 3512 10 24-28IN	6/14/2010	**140**
BUILDING 3512 11 0-6IN	6/14/2010	**170**
BUILDING 3512 11 12-18IN	6/14/2010	**110**
BUILDING 3512 11 24-28IN	6/14/2010	**100**
BUILDING 3512 12 0-6IN	6/14/2010	**110**
BUILDING 3512 12 12-18IN	6/14/2010	**110**
BUILDING 3512 12 24-28IN	6/14/2010	**110**
BUILDING 3512 13 0-6IN	6/14/2010	**120**
BUILDING 3512 13 12-18IN	6/14/2010	**110**
BUILDING 3512 13 24-28IN	6/14/2010	**100**
BUILDING 3512 14 0-6IN	6/14/2010	**150**
BUILDING 3512 14 12-18IN	6/14/2010	**120**
BUILDING 3512 14 24-28IN	6/14/2010	**110**
BUILDING 3512 15 0-6IN	6/14/2010	**110**
BUILDING 3512 15 12-18IN	6/14/2010	**110**
BUILDING 3512 15 24-28IN	6/14/2010	**100**
BUILDING 3512 16 0-6IN	6/14/2010	**100**
BUILDING 3512 17 0-6IN	6/14/2010	**87**
BUILDING 3512 18 0-6IN	6/14/2010	**18**
BUILDING 3512 19 0-6IN	6/14/2010	**5.7**
BUILDING 3512 19 12-18IN	6/14/2010	<4.7
BUILDING 3512 19 24-28IN	6/14/2010	<2.4
BUILDING 3512 19 30-36IN	6/14/2010	<2.3
DUPLICATE 20 30-36IN	6/14/2010	<5.1
BUILDING 3512 28 12-18IN	6/14/2010	<4.9

Parameter		Lead
Units		mg/kg
Sample Identification	Sample Date	Value
BUILDING 4203		
BUILDING 4203 01 0-6IN	6/16/2010	**140**
BUILDING 4203 01 12-18IN	6/16/2010	**150**
BUILDING 4203 01 24-28IN	6/16/2010	**120**
BUILDING 4203 01 30-36IN	6/16/2010	**110**
BUILDING 4203 02 0-6IN	6/16/2010	**120**
BUILDING 4203 02 12-18IN	6/16/2010	**120**
DUPLICATE 29 12-18IN	6/16/2010	**30**
BUILDING 4203 02 24-28IN	6/16/2010	**140**
BUILDING 4203 03 0-6IN	6/16/2010	**120**
BUILDING 4203 03 12-18IN	6/16/2010	**160**
BUILDING 4203 03 24-28IN	6/16/2010	**110**
BUILDING 4203 04 0-6IN	6/16/2010	**110**
BUILDING 4203 04 12-18IN	6/16/2010	**120**
BUILDING 4203 05 0-6IN	6/16/2010	**130**
BUILDING 4203 05 12-18IN	6/16/2010	**100**
BUILDING 4203 05 24-28IN	6/16/2010	**110**
BUILDING 4203 05 30-36IN	6/16/2010	**110**
BUILDING 4203 06 0-6IN	6/16/2010	**130**
BUILDING 4203 06 12-18IN	6/16/2010	**120**
BUILDING 4203 06 24-28IN	6/16/2010	**110**
BUILDING 4203 07 0-6IN	6/16/2010	**12**
BUILDING 4203 07 12-18IN	6/16/2010	**5.4**
BUILDING 4203 07 24-28IN	6/16/2010	**21**
BUILDING 4203 08 0-6IN	6/16/2010	**32**
BUILDING 4203 08 12-18IN	6/16/2010	**16**
BUILDING 4203 08 24-28IN	6/16/2010	<2.5
BUILDING 4203 09 0-6IN	6/16/2010	**16**
BUILDING 4203 09 12-18IN	6/16/2010	<2.5
DUPLICATE 30 12-18IN	6/16/2010	<2.5
BUILDING 4203 09 24-28IN	6/16/2010	<2.5
BUILDING 4203 10 0-6IN	6/16/2010	**14**
BUILDING 4203 10 12-18IN	6/16/2010	**26**
BUILDING 4203 10 24-28IN	6/16/2010	**30**
BUILDING 4203 11 0-6IN	6/16/2010	**13**
BUILDING 4203 11 12-18IN	6/16/2010	<2.5
BUILDING 4203 11 24-28IN	6/16/2010	**9.9**
BUILDING 4203 12 0-6IN	6/16/2010	**11**
BUILDING 4203 12 12-18IN	6/16/2010	**4.9**
BUILDING 4203 12 24-28IN	6/16/2010	<5.0
BUILDING 4203 13 0-6IN	6/16/2010	**19**
BUILDING 4203 13 12-18IN	6/16/2010	**2.7**
BUILDING 4203 13 24-28IN	6/16/2010	**320**

Parameter		Lead
Units		mg/kg
Sample Identification	Sample Date	Value
BUILDING 4203 14 0-6IN	6/16/2010	**60**
BUILDING 4203 15 0-6IN	6/16/2010	**23**
BUILDING 4203 16 0-6IN	6/16/2010	**50**
BUILDING 4203 17 0-6IN	6/16/2010	**9.9**
BUILDING 4210		
BUILDING 4210 01 0-6IN	6/16/2010	**23**
BUILDING 4210 01 12-18IN	6/16/2010	**12**
BUILDING 4210 01 24-28IN	6/16/2010	**200**
BUILDING 4210 02 0-6IN	6/16/2010	**19**
BUILDING 4210 02 12-18IN	6/16/2010	<2.5
BUILDING 4210 02 24-28IN	6/16/2010	<13
BUILDING 4210 03 0-6IN	6/16/2010	**170**
BUILDING 4210 03 12-18IN	6/16/2010	<2.5
BUILDING 4210 03 24-28IN	6/16/2010	<5.0
BUILDING 4210 04 0-6IN	6/16/2010	**13**
BUILDING 4210 04 12-18IN	6/16/2010	<5.0
BUILDING 4210 04 24-28IN	6/16/2010	<2.5
DUPLICATE 31 24-28IN	6/16/2010	<2.7
BUILDING 4210 05 0-6IN	6/16/2010	**20**
BUILDING 4210 05 12-18IN	6/16/2010	**1.4**
BUILDING 4210 05 24-28IN	6/16/2010	**7.1**
BUILDING 4210 06 0-6IN	6/16/2010	**2.2**
BUILDING 4210 06 12-18IN	6/16/2010	<2.5
BUILDING 4210 06 24-28IN	6/16/2010	<5.0
BUILDING 4210 06 30-36IN	6/16/2010	<13
BUILDING 4210 07 0-6IN	6/16/2010	**6.4**
BUILDING 4210 07 12-18IN	6/16/2010	<5.0
BUILDING 4210 07 24-28IN	6/16/2010	<13
BUILDING 4210 08 0-6IN	6/16/2010	**0.92**
BUILDING 4210 08 12-18IN	6/16/2010	**0.91**
BUILDING 4210 08 24-28IN	6/16/2010	<2.5
BUILDING 4210 09 0-6IN	6/16/2010	<2.5
BUILDING 4210 09 12-18IN	6/16/2010	<5.0
BUILDING 4210 09 24-28IN	6/16/2010	<5.0
BUILDING 4210 10 0-6IN	6/16/2010	<2.5
BUILDING 4210 10 12-18IN	6/16/2010	<2.5
BUILDING 4210 10 24-28IN	6/16/2010	**3.8**
BUILDING 4210 11 0-6IN	6/16/2010	**8.6**
DUPLICATE 32 0-6IN	6/16/2010	**11**
BUILDING 4210 11 12-18IN	6/16/2010	**9.4**
BUILDING 4210 11 24-28IN	6/16/2010	**2.9**
BUILDING 4210 12 0-6IN	6/16/2010	**5.4**
BUILDING 4210 12 12-18IN	6/16/2010	<2.5

Parameter		Lead
Units		mg/kg
Sample Identification	Sample Date	Value
BUILDING 4210 12 24-28IN	6/16/2010	<4.9
BUILDING 4210 13 0-6IN	6/16/2010	<2.5
BUILDING 4210 13 12-18IN	6/16/2010	<2.4
BUILDING 4210 13 24-28IN	6/16/2010	<4.7
BUILDING 5303		
BUILDING 5303 01 0-6IN	6/11/2010	**67**
BUILDING 5303 01 12-18IN	6/11/2010	**50**
BUILDING 5303 01 24-28IN	6/11/2010	<2.3
DUPLICATE 01 24-28IN	6/11/2010	<2.6
BUILDING 5303 01 30-36IN	6/11/2010	<2.4
BUILDING 5303 02 0-6IN	6/11/2010	**33**
BUILDING 5303 02 12-18IN	6/11/2010	**9.5**
DUPLICATE 02 12-18IN	6/11/2010	<4.8
BUILDING 5303 02 24-28IN	6/11/2010	<2.5
BUILDING 5303 03 0-6IN	6/11/2010	**100**
BUILDING 5303 03 12-18IN	6/11/2010	**19**
BUILDING 5303 03 24-28IN	6/11/2010	**15**
BUILDING 5303 04 0-6IN	6/11/2010	**23**
BUILDING 5303 04 12-18IN	6/11/2010	<2.6
BUILDING 5303 04 24-28IN	6/11/2010	<2.5
BUILDING 5303 05 0-6IN	6/11/2010	**120**
BUILDING 5303 05 12-18IN	6/11/2010	**110**
DUPLICATE 04 12-18IN	6/11/2010	<2.3
BUILDING 5303 05 24-28IN	6/11/2010	<2.6
BUILDING 5303 06 0-6IN	6/11/2010	**47**
BUILDING 5303 06 12-18IN	6/11/2010	**160**
BUILDING 5303 06 24-28IN	6/11/2010	**82**
BUILDING 5303 07 0-6IN	6/11/2010	**15**
DUPLICATE 03 0-6IN	6/11/2010	**20**
BUILDING 5303 07 12-18IN	6/11/2010	<4.6
BUILDING 5303 07 24-28IN	6/11/2010	<5.1
BUILDING 5303 08 0-6IN	6/11/2010	**22**
BUILDING 5303 08 12-18IN	6/11/2010	<2.3
BUILDING 5303 08 24-28IN	6/11/2010	**1.1**
BUILDING 5303 09 0-6IN	6/11/2010	**3.9**
BUILDING 5303 09 12-18IN	6/11/2010	<2.3
BUILDING 5303 09 24-28IN	6/11/2010	<2.3
BUILDING 5303 10 0-6IN	6/11/2010	**170**
BUILDING 5303 10 12-16IN	6/11/2010	**1,100**
BUILDING 5303 11 0-6IN	6/11/2010	**68**
BUILDING 5303 11 12-18IN	6/11/2010	**11**
BUILDING 5303 11 24-28IN	6/11/2010	<4.7
BUILDING 5303 12 0-6IN	6/11/2010	**80**

Parameter		Lead
Units		mg/kg
Sample Identification	Sample Date	Value
BUILDING 5303 12 12-18IN	6/11/2010	**80**
BUILDING 5303 12 24-28IN	6/11/2010	**28**
BUILDING 5303 13 0-6IN	6/11/2010	**11**
BUILDING 5303 13 12-18IN	6/11/2010	**4.5**
BUILDING 5303 13 24-28IN	6/11/2010	<4.8
BUILDING 5303 14 0-6IN	6/11/2010	**420**
BUILDING 5303 14 12-18IN	6/11/2010	**65**
BUILDING 5303 14 24-28IN	6/11/2010	**20**
BUILDING 5303 15 0-6IN	6/11/2010	<2.6
BUILDING 5303 15 12-18IN	6/11/2010	<2.5
BUILDING 5303 15 24-28IN	6/11/2010	<5.1
BUILDING 5303 16 0-6IN	6/11/2010	**5.7**
BUILDING 5303 16 12-18IN	6/11/2010	**74**
BUILDING 5303 16 24-28IN	6/11/2010	<5.2
BUILDING 5303 17 0-6IN	6/11/2010	**17**
BUILDING 5303 17 12-18IN	6/11/2010	<2.3
BUILDING 5303 17 24-28IN	6/11/2010	<2.6
BUILDING 5303 17 30-36IN	6/11/2010	<4.8
BUILDING 5303 18 0-6IN	6/11/2010	**12**
BUILDING 5303 18 12-18IN	6/11/2010	**12**
BUILDING 5303 18 20-21IN	6/11/2010	<2.5
BUILDING 5303 19 0-6IN	6/11/2010	**390**
BUILDING 5303 19 12-18IN	6/11/2010	**64**
BUILDING 5303 19 24-28IN	6/11/2010	**24**
BUILDING 5303 20 0-6IN	6/11/2010	**42**
BUILDING 5303 20 12-18IN	6/11/2010	<2.5
BUILDING 5303 20 24-28IN	6/11/2010	<5.0
BUILDING 5303 21 0-6IN	6/11/2010	**140**
BUILDING 5303 21 12-18IN	6/11/2010	**100**
BUILDING 5303 21 24-28IN	6/11/2010	**40**
BUILDING 5303 22 0-6IN	6/11/2010	<2.5
BUILDING 5303 22 12-18IN	6/11/2010	<2.5
BUILDING 5303 22 24-28IN	6/11/2010	<5.0
BUILDING 5303 23 0-6IN	6/11/2010	**7.1**
BUILDING 5303 23 12-18IN	6/11/2010	<5.0
BUILDING 5303 23 24-28IN	6/11/2010	<5.0
BUILDING 5303 24 0-6IN	6/11/2010	**13**
BUILDING 5303 24 12-18IN	6/11/2010	<2.5
BUILDING 5303 24 24-28IN	6/11/2010	<5.0
BUILDING 5303 25 0-6IN	6/11/2010	**16**
BUILDING 5303 25 12-18IN	6/11/2010	<2.3
BUILDING 5303 25 24-28IN	6/11/2010	**190**
BUILDING 5303 26 0-6IN	6/11/2010	**31**

Parameter		Lead
Units		mg/kg
Sample Identification	Sample Date	Value
BUILDING 5303 26 12-18IN	6/11/2010	<5.2
BUILDING 5303 26 24-28IN	6/11/2010	<4.6
BUILDING 5303 26 30-36IN	6/11/2010	<2.8
BUILDING 5303 27 0-6IN	6/11/2010	**250**
BUILDING 5303 27 12-18IN	6/11/2010	<4.9
BUILDING 5303 27 24-28IN	6/11/2010	<2.7
OPPORTUNISTIC		
OPPORTUNISTIC 01 0-6IN	6/15/2010	**4**
DUPLICATE 28 0-6IN	6/15/2010	**44**
OPPORTUNISTIC 02 0-6IN	6/15/2010	**43**
OPPORTUNISTIC 03 0-6IN	6/15/2010	**36**
OPPORTUNISTIC 04 0-6IN	6/15/2010	**480**
OPPORTUNISTIC 05 0-6IN	6/15/2010	**62**
OPPORTUNISTIC 06 0-6IN	6/15/2010	**6.5**
OPPORTUNISTIC 07 0-6IN	6/15/2010	**82**
OPPORTUNISTIC 08 0-6IN	6/15/2010	**220**
OPPORTUNISTIC 09 0-6IN	6/15/2010	**520**
OPPORTUNISTIC 10 0-6IN	6/15/2010	**190**
OPPORTUNISTIC 11 0-6IN	6/15/2010	**220**
OPPORTUNISTIC 12 0-6IN	6/15/2010	**64**
OPPORTUNISTIC 13 0-6IN	6/16/2010	**370**
DUPLICATE 33 0-6IN	6/16/2010	**260**
OPPORTUNISTIC 14 0-6IN	6/16/2010	**470**
OPPORTUNISTIC 15 0-6IN	6/16/2010	**640**
OPPORTUNISTIC 16 0-6IN	6/16/2010	**920**

Notes:

Bold = Analyte Detect

<2.7 = Results are less than method reporting limit.

mg/kg - milligrams per kilogram

Table 4

Summary of Chemical Analytical Data
Leachable Lead Results
Midway Atoll National Wildlife Refuge

Parameter		Leachable Lead
Units		mg/l
Sample Identification	Sample Date	Value
BUILDING 363 01 0-6IN	6/12/2010	**0.093**
BUILDING 363 04 0-6IN	6/12/2010	**0.48**
BUILDING 363 12 0-6IN	6/12/2010	<0.25
BUILDING 5303 10 12-16IN	6/12/2010	<0.25
BUILDING 623 11 0-6IN	6/12/2010	**0.44**

Notes:

Bold = Analyte Detected

mg/l = milligrams per liter

<0.25 = not detected above the method reporting limit.

Table 5

Summary of Chemical Analytical Data
2010 XRF Field Data and EPA Method 6010 Total Lead Results
Midway Atoll National Wildlife Refuge

Sample Location	XRF Result (ppm)	XRF Error[1] (ppm)	EPA 6010B Result (mg/kg)	Relative Percent Difference
Background 02 0-6IN	<31.1	--	5	--
Background 02 30-36IN	<36.4	--	6.4	--
Background 05 0-6IN	<31.3	--	25	--
Background 15 0-6IN	131.8	29.4	140	-8%
Background 15 24-28IN	40.1	24.9	45	-13%
Background 15 30-36IN	43	24.9	16	97%
Background 16 0-6IN	162.8	31.8	250.0	-59%
Background 16 12-18IN	313.3	40.9	930	-144%
Building 1124 01 0-6IN	<33.5	--	21	--
Building 1124 02 12-18IN	57	25.3	57	0%
Building 1124 02 24-28IN	164.9	32.1	120	42%
Building 1124 03 24-28IN	53.5	25.1	51	6%
Building 1124 07 0-6IN	45.3	23.1	40	15%
Building 1124 08 0-6IN	50.2	25.3	30	57%
Building 1124 13 12-18IN	<33.6	--	25	--
Building 1124 16 0-6IN	<35.5	--	12	--
Building 3504 01 0-6IN	86.4	25.8	28	125%
Building 3504 02 0-6IN	<33.3	--	91	--
Building 3504 06 0-6IN	26.2	16.7	35	-34%
Building 3504 06 24-28IN	<26.3	--	12	--
Building 3504 08 0-6IN	46	22.7	140	-135%
Building 3504 08 24-28IN	91.3	25.2	180	-90%
Building 3504 08 30-36IN	<29.8	--	98	--
Building 3504 09 12-18IN	<28.2	--	120	--
Building 3504 12 0-6IN	<32.5	--	87.0	--
Building 3504 12 12-18IN	<31.7	--	140	--
Building 3504 14 24-28IN	<27.4	--	97	--
Building 3504 21 12-18IN	<30.7	--	22	--
Building 3504 23 12-18IN	<28.9	--	45	--
Opportunistic 02 0-6IN	<34.4	--	43.0	--
Opportunistic 05 0-6IN	57	25.7	62	-10%
Opportunistic 09 0-6IN	823.1	54.9	520	65%
Opportunistic 13 0-6IN	425.4	45	370	20%
Opportunistic 15 0-6IN	580.1	52.4	640	-14%
Opportunistic 16 0-6IN	469.7	48.6	920	-94%
Building 363 01 0-6IN	495.6	49.1	1000	-98%
Building 363 01 12-18IN	69.9	26.2	43	58%
Building 363 02 12-18IN	<35.2	--	23	--
Building 363 02 24-28IN	43.3	24.8	46	-7%

Sample Location	XRF Result (ppm)	XRF Error[1] (ppm)	EPA 6010B Result (mg/kg)	Relative Percent Difference
Building 363 04 0-6IN	601.7	54.4	980	-69%
Building 363 04 12-18IN	453.2	48.7	490	-11%
Building 363 06 0-6IN	69.3	27.1	85	-26%
Building 363 09 0-6IN	282.5	38.5	370	-38%
Building 363 12 0-6IN	<33.8	--	9300	--
Building 363 12 12-18IN	<34.90	--	130	--
Building 363 16 0-6IN	201.4	32.2	330	-68%
Building 4203 01 12-18IN	<34.1	--	150	--
Building 4203 08 12-18IN	<34.6	--	16	--
Building 4203 10 24-28IN	<33.2	--	26	--
Building 4203 13 24-28IN	<29.1	--	2.7	--
Building 4210 01 24-28IN	<31.1	--	200	--
Building 421 03 0-6IN	53.9	23.5	95	-72%
Building 421 05 12-18IN	53.9	24.3	160	-134%
Building 421 12 0-6IN	<28.2	--	250	--
Building 421 16 0-6IN	<68.5	36.9	380	--
Building 421 18 0-6IN	118.2	28.5	100	22%
Building 421 19 0-6IN	466	46.7	540	-21%
Building 3512 02 24-28IN	476	49.5	410	21%
Building 3512 03 0-6IN	<32.6	--	27	--
Building 3512 06 0-6IN	41.2	23	58	-41%
Building 3512 10 0-6IN	<30.8	--	17	--
Building 3512 11 24-28IN	<28.6	--	100	--
Building 3512 13 0-6IN	<29.8	--	120	--
Building 3512 14 24-28IN	<29.6	--	110	--
Building 3512 15 24-28IN	<28.8	--	100	--
Building 5303 01 0-6IN	202.5	34.1	67	134%
Building 5303 03 0-6IN	76	26.3	100	-36%
Building 5303 06 12-18IN	81.5	27.8	19	146%
Building 5303 06 0-6IN	<34.7	--	47	--
Building 5303 12 0-6IN	76.6	26.2	80	-6%
Building 5303 12 24-28IN	<34.9	--	28	--
Building 5303 13 24-28IN	<31.0	--	<4.8	--
Building 5303 14 24-28IN	<35.7	--	20	--
Building 5303 19 12-18IN	39.5	22.9	64	-58%
Building 5303 21 0-6IN	55	25.2	100	-75%
Building 2403 01 0-6IN	47.9	22.3	48	0%
Building 2403 03 12-18IN	69	25.5	230	-149%
Building 2403 05 0-6IN	<31.3	--	17	--
Building 2403 08 0-6IN	<36.7	--	15	--
Building 2403 11 12-18IN	<30.3	--	100	--
Building 2403 14 0-6IN	<30.3	--	150	--
Building 2403 17 0-6IN	127.4	29.9	240	-85%
Building 2403 20 0-6IN	46.9	23.1	160	-148%
Building 2403 20 12-18IN	<29.1	--	120	--

Sample Location	XRF Result (ppm)	XRF Error[1] (ppm)	EPA 6010B Result (mg/kg)	Relative Percent Difference
Building 623 1 0-6IN	598.8	50.2	670	-16%
Building 623 2 12-18IN	361	43.2	550	-59%
Building 623 3 12-18IN	159.6	31.7	250	-61%
Building 623 6 24-28IN	<25.4	--	99	--
Building 623 9 12-18IN	266.2	39.1	400	-57%
Building 623 10 0-6IN	268.7	38.6	390	-52%
Building 623 11 0-6IN	998.9	66	1100	-14%
Building 623 13 12-18IN	<34.6	--	45	--
Building 623 14 0-6IN	432.1	46.7	430	1%
Building 623 17 12-18IN	82.4	26.8	78	7%
Building 623 19 0-6IN	440.6	47.3	550	-32%
Building 623 19 12-18IN	59	25.1	160	-124%

Notes:

[1]XRF Error refers to the occurance of the XRF results.

XRF = X-Ray Fluorescence Testing

RPD = Relative Percent Difference

ppm = parts per million

mg/kg = milligrams per kilograms

Table 6

Potential Chemical Specific ARARs

Midway Atoll National Wildlife Refuge

Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
EPA Regional Screening Levels (RSLs) (EPA, May 20, 2008)	To Be Considered	Numerical standards recommended for chemicals at Superfund sites. Guidance document.	For a residential land-use scenario, the RSLs are: 400 mg/kg for lead
RCRA Hazardous Waste Determination 40 CFR 261.21, 261.22, 261.23, and 261.29 and 40 CFR 261 Subchapter D	Applicable	A waste is considered a RCRA hazardous waste if it exhibits any of the characteristics of: ignitability, corrosivity, reactivity, or toxicity, or it is listed as a hazardous waste.	Wastes generated during construction, monitoring, or remediation must be characterized and managed in accordance with RCRA requirements (see Action-Specific ARARs).
Contained-In Policy (63 CFR 28618-28620; May 26, 1998) Management of soils containing hazardous waste	Applicable, if media containing hazardous waste is generated.	Contaminated media, of itself, is not hazardous waste. However, contaminated environmental media can be subject to regulation under RCRA if it "contains" hazardous waste.	Environmental media containing hazardous waste must be managed as hazardous waste until it no longer contains the hazardous waste.
Disposal of soils containing hazardous waste 40 CFR 268	Applicable	If hazardous waste is to be disposed of on land (such as, placed in a landfill), it must first be treated to meet the LDRs found in 40 CFR 268. Debris treatment is an action-specific ARAR. If the soil is a characteristic hazardous waste (for example, it fails TCLP for lead), it must be treated for the characteristic that makes it hazardous (e.g., lead) and all other underlying hazardous constituents (UHCs, those constituents above the Universal Treatment Standards [UTSs] in 40 CFR 268.48)	

Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
		Under 40 CFR 268.49, soils contaminated by hazardous waste must be treated until the hazardous constituent concentrations are either: 1. 90% of the initial concentrations, or 2. 10x the UTS for nonwastewaters found in 40 CFR 268.48. The soils must be treated to the higher of these two standards. If soil containing hazardous waste is treated on site prior to land disposal (even if the disposal is off site), a waste analysis plan is needed in accordance with 40 CFR 268.7(a)(5).	
Management of remediation waste in a Corrective Action Management Unit (CAMU)	Applicable, if a CAMU is used	Remediation wastes are all solid and hazardous wastes and all media and debris associated with a site cleanup. Remediation wastes can be placed in a CAMU if the principal hazardous constituents (PHCs) are treated before placement.	A discussion of CAMU design requirements is included under the Action-Specific ARARs.
40 CFR 264.552		Those constituents that are PHCs that fail TCLP (e.g. lead) must be treated before being disposed of. If there is a PHC, then the remediation waste will need to be treated for that PHC before placing it in the CAMU.	If the contaminated waste is debris (e.g., concrete, steel), then the debris needs to be treated as hazardous waste debris and decontaminated (see discussion under the Action-Specific ARARs).

Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
EPA Revised Interim Soil-lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities	To Be Considered	Establishes screening levels for lead in soil for residential land use, describes development of site-specific preliminary remediation goals, and describes a plan for soil-lead cleanup at CERCLA sites. Office of Solid Waste and Emergency Response (OSWER) Directive 9355.4-12, July 14, 1994	This guidance recommends using the EPA Integrated Exposure Uptake Biokinetic Model (IEUBK) on a site-specific basis to assist in developing cleanup goals.
EPA Strategy for Reducing Lead Exposures	To Be Considered	Presents a strategy to reduce lead exposure, particularly to young children. EPA, February 21, 1991	The strategy was developed to reduce lead exposure to the greatest extent possible. Goals of the strategy are to 1) significantly reduce the incidence above 10 µg Pb/dL in children; and 2) reduce the amount of lead introduced into the environment.

Notes:

ARAR - applicable or relevant and appropriate requirement
CAMU - Corrective Action Management Unit
CFR - Code of Federal Regulations
LDR - land disposal restriction
mg/kg - milligram per kilogram
PHC - principal hazardous constituents
PRG - Preliminary Remediation Goal (EPA Region IX)
RCRA - Resource Conservation and Recovery Act
RSL - Regional Screening Level
TCLP - toxicity characteristic leaching procedure
UHC - underlying hazardous constituent
USC - United States Code
UTS - Universal Treatment Standard

Table 7

Potential Location Specific ARARs

Midway Atoll National Wildlife Refuge

Location	Regulatory Citations	ARAR Status	Description	Comment
Cultural Resources				
Presence of archaeological resources	43 CFR 7	Applicable	May not excavate, remove, damage, or otherwise alter or deface such resource unless by permit or exception. Archeological resources are defined as those older than 100 years.	
Presence of human remains, funerary objects, sacred objects, or objects of cultural patrimony for Native Americans	43 CFR 10.4 (c) and (d)	Potentially applicable, if human remains are discovered during remediation	Must stop activities in the area of discovery and make a reasonable effort to secure and protect the objects discovered.	
Historic project owned or controlled by a federal agency	National Historic Preservation Act: 16 U.S.C. 470, et seq; 40 C.F.R. § 6.301; 36 C.F.R. Part 1.	Applicable	Property within areas of the Site is included in or eligible for the National Register of Historic Places.	The removal alternatives will be designed to minimize the effect on historic landmarks.
Site within an area where action may cause irreparable harm, loss, or destruction of artifacts.	Archeological and Historic Preservation Act; 16 U.S.C. 469, 40 C.F.R. 6.301.	To be considered	Property within areas of the site contains historical and archaeological data.	The removal alternative will be designed to minimize the effect on historical and archeological data.
Floodplains				
Within floodplain	Executive Order 11988, Floodplain Management	Potentially applicable	Avoid, to the extent possible, the long-and short-term adverse effects associated with occupancy and modification of floodplains.	Measures taken to mitigate adverse effects include minimum grading requirements, runoff controls, design and construction constraints, and protection of ecologically sensitive areas.

Location	Regulatory Citations	ARAR Status	Description	Comment
	44 CFR 9, Floodplain Management and Protection of Wetlands			
	Executive Order 11988, Floodplain Management 40 CFR 6.302(b), Floodplain Management	Potentially applicable	Potential effects of an action taken in a floodplain shall be evaluated. Identify, evaluate, and implement alternative actions that may avoid or mitigate adverse impacts on floodplains. If no practicable alternative exists, design or modify selected alternatives to minimize harm to or within floodplains and restore and preserve floodplain values.	
Within 100-year floodplain	40 CFR 264.18(b), Hazardous Waste Landfills, Floodplains	Applicable	Existing solid waste landfills and hazardous waste landfills located in a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout of any hazardous waste by a 100-year flood.	
Wetlands				
Wetlands	Executive Order 11990, Protection of Wetlands	Potentially applicable	Requires that actions be taken to avoid adverse effects on wetlands and prohibits discharge to wetlands.	These requirements would be applicable if the CAMU, treatment units, or associated facilities were constructed in wetlands.
	40 CFR 6.302(a) and Appendix A		Appendix A of 40 CFR 6 sets forth policy for carrying out provisions of the Protection of Wetlands Executive Order.	

Location	Regulatory Citations	ARAR Status	Description	Comment
Wetlands and surface water	Clean Water Act 33 USC §1344, Section 404(b)(1) 40 CFR 230.10 33 CFR 323.3(b)	Potentially applicable	Except as provided under Section 404(b)(2) of the Clean Water Act, discharge of dredged or fill material into an aquatic ecosystem is not permitted if there is a practicable alternative that would have less adverse impact.	
Shorelines				
Coastal zone	Coastal Zone Management Act, 16 USC §1463, et seq. 15 CFR 930	Potentially applicable	Activities affecting the coastal zone including wetland, floodplain, estuary, beach, dunes, reef, and fish and wildlife habitat in the coastal zone. Federal activities must be consistent with state coastal zone management plan (see next item).	
Shoreline area	Shoreline Setbacks, Chapter 23 ROH	Potentially applicable	Structures constructed must be set back 40 feet from the state-determined shoreline to minimize risk of adverse impacts on beach processes.	Structures may be built as part of the remediation (e.g., tanks, a building to store equipment).
Endangered Species and Other Animals				
Endangered or threatened species	Endangered Species Act, 16 USC §1531 Endangered and Threatened Species 50 CFR 17	Applicable	Activities affecting species listed as endangered or threatened or their critical habitat is regulated. Prohibits the taking, harassment, harming, or killing of endangered or threatened species of flora and fauna.	If the removal proposed impacts endangered or threatened species or habitat, NOAA, USFWS, and/or NMFS should be informally consulted.
Any species of native bird	Migratory Bird Treaty Act	Applicable	The taking of any native species of wild bird is prohibited.	Removal activities that might affect migratory birds will require consultation with USFWS. Removal alternatives shall consider effects on migratory birds.

Location	Regulatory Citations	ARAR Status	Description	Comment
Coral reefs	Coral Reef Conservation Act	Relevant and appropriate, for remedies affecting coral reefs	Preserve, sustain, and restore coral reef ecosystems by reducing the impacts of pollution on coral reefs.	

Notes:

ARAR - applicable or relevant and appropriate requirement

CFR - Code of Federal Regulations

NMFS - National Marine Fisheries Service

NOAA - National Oceanic and Atmospheric Administration

USC - United State Code

ARAR status depends on the specific removal alternatives evaluated. ARAR status will be reevaluated once the remedy is selected.

Table 8

Potential Action Specific ARARs

Midway Atoll National Wildlife Refuge

Action	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Site Preparation, Construction, and Excavation Activities				
Activities that effect historical structures	National Historic Preservation Act 36 CFR 800	Applicable, if construction activities will disturb historical strucutures	FWS will consult historical assocaitions as needed.	FWS will consult historical assocaitions as needed.
Activities that effect historical structures Activities causing stormwater runoff from construction activities	Memorandum of Agreement between FWS and Honolulu Historic Preservation Office 40 CFR 122 26(b)(15)	Applicable to work performed around the Cable Buildings Applicable, if construction activities disturb more than 1 acre of land.	FWS will need to address the MOA between FWS and Honolulu Historical Preservation Office. Implement good construction management techniques, sediment and erosion controls, storm water management measures, and housekeeping best management practices (BMPs) to ensure stormwater discharges comply with the substantive requirements of the Stormwater General Permit (http://www.epa.gov/npdes/pubs/cap2003.fs.pdf).	FWS may work with the Preservation Office to modify or change the MOA. Construction activities (including other land-disturbing activities) that disturb one acre or more are regulated under the NPDES stormwater program; this includes smaller sites that are part of a larger common plan of development. At other bases, EPA has interpreted this to mean all of the remediation sites on-base together are the planned development.
Activities causing stormwater runoff from construction activities	NPDES General Permit for Discharges from Large and Small Construction Activities, effective January 21, 2005, Section 3	To be considered	A Stormwater Pollution Prevention Plan (SWPPP) will be prepared.	
Discharges to a sediment pond	NPDES General Permit for Discharges from Large and Small Construction Activities, Section 3.6C	To be considered	Sediment from sediment traps or ponds must be removed when design capacity has been reduced by 50%.	

Action	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Activities causing stormwater runoff from construction activities	NPDES General Permit for Discharges from Large and Small Construction Activities, Section 3.10	To be considered	Inspections must be conducted every 7 days OR at least once every 14 days and within 24 hours of the end of a storm event of 0.5 inches or more. Specific information must be collected, and the inspections must be performed by a qualified person.	
Activities causing stormwater runoff from construction activities	NPDES General Permit for Discharges from Large and Small Construction Activities, Section 3.13	To be considered	Stabilization measures must be implemented within 14 days after construction is temporarily or permanently halted.	
Asbestos	40 CFR 61 Subpart M	Applicable, if debris with asbestos is encountered during remediation.	Asbestos-containing wastes must be managed in a certain manner.	
Materials Management				
Storage of fuels and oils in quantities greater than 1,320 gallons in 55 gallon drums or larger	40 CFR 112	Potentially applicable, if fuels and oils are stored.	All containers ≥55 gallons must be secondarily contained, inspected routinely, have a spill prevention, control, and countermeasures (SPCC) plan prepared, and meet other specific SPCC requirements.	

Action	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Waste Generation/Management				
Generate used oil	40 CFR 279	Potentially applicable, if used oil is generated or discovered during remedial activities.	No new oil, used oil, or recycled oil shall be discharged or caused or allowed to enter into sewers, drainage systems, surface or ground waters, water courses, marine waters, or onto the ground; no person shall transport, market or recycle used oil except by permit; all transporters, receivers, recyclers and burners of used oil must invoice all transactions; used oil that exceeds halogen concentrations of 1,000 ppm must be disposed of as hazardous waste.	
Generate solid wastes as defined in 40 CFR 261.2	40 CFR 262.11(a)	Applicable	Wastes generated during a study or a remedial action would be characterized to determine if such wastes are hazardous (e.g., contaminated PPE, equipment, wastewater) or excluded under 40 CFR 261.4.	
	40 CFR 262.11(b)	Applicable	Determine if the waste is listed hazardous waste under 40 CFR 261 (i.e., is F-, K-, P-, or U-listed waste).	
	40 CFR 262.11(c)	Applicable	Determine if the waste is hazardous by testing using prescribed methods (i.e., the waste is reactive, corrosive, ignitable, or toxic [the D waste codes]) or by applying generator knowledge based on information regarding material or processes used.	
	40 CFR 262.11(d)	Potentially applicable, depending on the waste constituents.	If waste is hazardous, it must be managed in accordance with the hazardous waste regulations.	

Action	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Hazardous waste accumulation	40 CFR 262.34	Potentially applicable, depending on the waste constituents.	These requirements are applicable to hazardous waste that is held temporarily on site prior to off-site disposal. Very specific requirements are discussed in the regulations, including labeling, management, training, and others. Consult the regulations for specific information.	Accumulation of hazardous wastes on site for longer than 90 days would be subject to RCRA requirements for storage facilities.
Waste Storage				
Hazardous Waste				
Container Storage	40 CFR 264.171 through 175, 179; 40 CFR 262.34(c)(1)	Potentially applicable, depending on the waste constituents.	Containers of RCRA hazardous waste must: be maintained in good condition; be compatible with hazardous waste to be stored; be closed during storage except to add or remove waste; be inspected weekly; have adequate secondary containment when stored on site; and be marked with "hazardous waste" or other words identifying contents.	These requirements are applicable to hazardous wastes that are generated and stored temporarily in containers at the site prior to off-site disposal and may include wastes such as soil, debris, or treatment residuals (water, sludge, filters).
	40 CFR 264.175 (a) and (b)	Potentially applicable, depending on the waste constituents.	Place containers on a sloped, crack-free base, and protect from contact with accumulated liquid. Provide a containment system with a capacity of 10 percent of the volume of containers with liquids. Remove spilled or leaked waste in a timely manner to prevent overflow of the containment system.	These requirements are applicable to hazardous wastes that are generated and stored temporarily in containers at the site prior to off-site disposal.

Action	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Container management	40 CFR 262.30 through 33	Potentially applicable, depending on the waste constituents.	Prior to transportation, containers would be packaged, labeled, marked, and placarded in accordance with RCRA and Department of Transportation requirements.	These requirements are applicable to containers that are used to hold hazardous wastes that are sent off site for disposal.
Recordkeeping for hazardous wastes sent off site	40 CFR 262.40	Potentially applicable, depending on the waste constituents.	Records of wastes sent off site must be kept and reported to EPA. Manifests discrepancy and late reports must be submitted to EPA.	Only applies to wastes sent off site.
Water Discharges				
Discharge of any substance into state waters or from a treatment works or waste outlet	NPDES	Potentially applicable, if the discharge goes off site (i.e., into the lagoon).	Requires an NPDES permit for discharging any pollutant and requires public participation in the permitting process.	
	40 CFR 122.21	Relevant and Appropriate if discharge is completely on site.		
Excavation				
Excavation	40 CFR 268.40	Potentially applicable, depending on the waste constituents.	Movement of excavated materials characterized as hazardous to new location or placement in or on land will trigger LDRs for the excavated material.	Applicable if excavated soil and waste characterized as hazardous waste is placed on land (e.g., accumulation of soil prior to disposal). LDRs must be met for wastes excavated and then placed in an area outside of a corrective action management unit, treatment unit, or staging pile.

Action	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
				The federal rules allow a 10x the waste LDR concentration for land disposal of soils under 40 CFR 268.49 or a soil treatability variance according to 40 CFR 268.44 (h)(3) and (4).
Habitat restoration	National Environmental Policy Act, 42 USC §4371 et. seq., 40 CFR 1508.20, USFWS Mitigation Policy (46 FR 7644 to 7663, 1981)	Not applicable for CERCLA actions	Regulates activities that could affect habitat for federally protected species. Mitigation includes: •Avoiding the impact altogether by not taking a certain action or parts of an action. •Minimizing impacts by limiting the degree or magnitude of the action and •Rectifying the impact by repairing, rehabilitating, or restoring the affected •Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action. •Compensating for the impact by replacing or providing substitute resources or environments.	
Solid Waste Disposal				
Solid waste disposal	Solid Waste Disposal Act, 42 USC §6901 et. Seq. Subtitle D	Potentially applicable	Establishes procedures and minimum requirements for land disposal of solid waste.	If solid wastes are stored or disposed off site or off island, all RCRA permitting regulations must be complied with.
Solid waste disposal	40 CFR 257	Potentially applicable, if solid wastes are disposed of.	Establishes minimum standards for solid waste disposal facilities, including banning open burning.	

Action	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Wastes sent off site	off site Rule 40 CFR 300.440	Applicable	Any CERCLA wastes sent off-site must be sent to a facility reviewed by EPA under the off-site rule (OSR). CERCLA wastes include all wastes and media containing CERCLA hazardous substances.	Hazardous wastes are a subset of CERCLA wastes. CERCLA wastes can pass TCLP, and still must go to an EPA-approved facility.
Hazardous Waste Management Units and Disposal				
Management of remediation waste in a Corrective Action Management Unit (CAMU)	40 CFR 264.552	Potentially applicable	CAMUs can be used to consolidate remediation wastes from various sites on the same facility. A CAMU most be designated either in a permit, order, or in a CERCLA decision document. CAMUs most be designed to meet three criteria. These criteria are: 1. Minimum composite liner and leachate collection system requirements for new, replacement, or laterally expanded CAMUs (e.g., 10-7 permeability, see 40 CFR 264.552[el[3][i]). For the purposes of the CAMU design standards, solid waste management units that are in existence at the time of a remedial action are not considered "new" units if they are designated as a CAMU.	The CAMU will need to be designated in the ROD or Action Memorandum prior to implementation of the remedial action. It can be constructed as part of the remedial action.

Action	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
			2. Minimum design criteria for CAMU caps. 3. Take corrective action, as necessary to protect human health and the environment, for releases from CAMUs to groundwater. If all of the constituents in the wastes going into the CAMU are at or below remedial goals, then the above liner criteria, capping criteria, and groundwater monitoring are not required.	
Disposal of non-hazardous waste in a CAMU	40 CFR 264.552[a][1][iii]	Applicable if a CAMU is used	Non-hazardous wastes may be placed in the CAMU, if it facilitates implementation of the corrective action. Remediation wastes from any site could be taken to the CAMU, as long as it is discussed in the decision document. Note that as-generated wastes from industrial operations could not be taken to the CAMU, but as-generated non-hazardous waste (e.g., trash such as paper towels, cardboard) can be placed in the CAMU when it facilitates implementation of the corrective action). Liquids may not be placed in the CAMU.	
Disposal of RCRA hazardous waste in a land-based unit (not a CAMU)	RCRA, LDRs, 40 CFR 268	Potentially applicable	Hazardous waste may be land disposed of only if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 CFR 268.40 before land disposal.	Land disposal of hazardous wastes may be part of the selected remedy. See also discussion under "Excavation" above.

Action	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Disposal of debris containing hazardous waste	40 CFR 268.45	Potentially applicable	If debris is contaminated by a hazardous waste (e.g. soils on/adjacent to the debris are hazardous per 40 CFR 261), the debris is called hazardous debris. Hazardous debris must be treated in accordance with the 40 CFR 268.45 standards before it can be land disposed of. This treatment essentially consists of a specialized decontamination.	
Treatment in tanks	40 CFR 264.192 through 194, and 196	Relevant and Appropriate	These regulations include requirements to ensure that tanks and ancillary equipment are adequately designed, operated, and maintained to ensure that the tank system will not fail.	Substantive portions of these requirements may be relevant and appropriate to tanks that are used during hazardous waste treatment.
Waste pile	40 CFR 264.251	Relevant and Appropriate	Hazardous waste that is put into piles is subject to LDRs. A double liner with leachate collection system is required, although a single liner may be used with EPA approval.	Relevant and Appropriate to non-containerized accumulation of solid nonflammable hazardous soil that may be stockpiled on site prior to treatment or off-site disposal.
Corrective action (temporary units)	40 CFR 264.553	Applicable	For temporary tanks and container storage areas used for treatment or storage of hazardous remediation waste during corrective action activities, it may be determined that a design, operating, or closure standard applicable to such units may be replaced by alternative requirements that are protective of human health or the environment The temporary unit may be in place for1 year with the possibility of 1-year extension.	This provision would allow for temporary treatment or storage of hazardous waste that is excavated, stored, and treated.

Action	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Corrective action (staging piles)	40 CFR 264.554	Relevant and Appropriate	During corrective action, remediation waste can be placed in piles without triggering LDRs or MTRs. Must not operate for more than 2 years and must be designated by appropriate agencies.	This provision would allow for temporary storage of remediation wastes characterized as hazardous before and/or after treatment.
Treatment in miscellaneous units	40 CFR 264.601/40 CFR 265.401	Relevant and Appropriate	These regulations include design, operation, maintenance, and closure requirements for miscellaneous treatment units and units that use chemical, physical, or biological treatment methods to treat hazardous waste.	These requirements are relevant and appropriate to units that treat waste ex situ.
General Facility/Operational Requirements				
Worker Safety	Occupational Safety and Health Rules, 29 CFR	Applicable	Regulates worker health and safety.	
Workplace exposure to contaminants from site cleanup	29 CFR 1910.120	Applicable	Ensures employers implement applicable procedures for the protection of employees against exposure or the reasonable possibility of exposure to safety and health risks during hazardous substance cleanup operations and hazardous waste operations pursuant to RCRA and during emergency response operations regarding hazardous substances.	

Action	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Groundwater Monitoring				
Water quality monitoring at hazardous waste landfills	Hazardous Waste Interim Status Standards 40 CFR 265.91 through 94. Hazardous Waste Permitted Standards 40 CFR 264.93, 94, 95, 97 and 98	To be considered	Establishes general requirements for water quality monitoring and response programs, including groundwater and the unsaturated zone, at permitted hazardous waste disposal facilities. Also addresses the point of compliance for groundwater monitoring.	
Groundwater monitoring at solid waste landfills	40 CFR 258 Subpart E	Applicable, if site is a landfill.	Specific types of data must be gathered for groundwater monitoring for solid waste landfills, including the location of the point of compliance. See the regulations for specific requirements.	
Closure and Postclosure Care				
Closure of hazardous waste units		Relevant and appropriate	Hazardous waste management units must be closed in a manner that minimizes the need for further maintenance and minimizes post-closure escape of hazardous constituents to groundwater, surface waters, or to the atmosphere.	
Postclosure care of a CAMU	40 CFR 552	Applicable	Groundwater monitoring and post closure care are required for CAMUs where wastes remain in place. Groundwater monitoring requirements are very general and should address (40 CFR 264.552[e][5])	
Municipal solid waste landfill	Closure and Postclosure Care 40 CFR 258 Subpart F	Applicable	All municipal solid waste landfill units must install a final cover system designed to minimize infiltration and erosion.	

Action	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Waste pile closure	40 CFR 264.258(a)	To be considered	At closure, owner shall remove or decontaminate all waste residues, contaminated containment system components, contaminated subsoils, structures, and equipment contaminated with waste and leachate, and manage them as hazardous waste.	
Hazardous waste landfill cover design	40 CFR 264.310(a)	To be considered	The final cover for a hazardous waste landfill must be designed.	The cover design requirements may be considered in guiding the design of cover improvements for the site.
Hazardous waste landfill cover maintenance	40 CFR 264.310(b)	To be considered	After closure, the owner of the landfill must comply with the postclosure requirements (40 CFR 264.117).	The cover maintenance requirements may be considered in guiding the design of cover improvements for the site.
Postclosure care	40 CFR 264.117	To be considered	Postclosure care lasts for 30 years unless otherwise decided by the EPA Administrator.	
Planning postclosure care	40 CFR 264.118	To be considered	A written postclosure care plan will be prepared.	
Notifications	40 CFR 264.119(a)	To be considered	Within 60 days of final closure, the zoning authority and EPA must be notified of the type, location, and quantity of hazardous waste disposed of at the facility.	

Action	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Notice in deed	40 CFR 264.119(b)	To be considered	A notice must be placed in the deed that the land has been used to manage hazardous wastes, the land use is restricted under Subchapter G regulations, and the notifications mentioned in 40 CFR 264.119(a) have been made. A certification that this information has been submitted must be made to EPA.	
Completion of postclosure care	40 CFR 264.120	To be considered	The owner/operator must submit a certification to the EPA that postclosure care has been completed in accordance with the plan within 60 days after completion of postclosure care.	
Transportation of Hazardous Material	Standards Applicable to Transporters of Hazardous Waste, 40 CFR 263.20 through 22	Applicable, if hazardous wastes are sent off site for disposal.	Sets standards that apply to persons transporting hazardous waste within the United States if transportation requires a manifest under 40 CFR 262. Transporter of hazardous waste must comply with the Manifest System and Record Keeping.	

Action	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
	Hazardous Materials Transportation Act, 40 USC §1811, 49 CFR 171-177	Applicable, if hazardous materials are sent off site.	Established standards for packaging, labeling, and transporting hazardous materials (which include hazardous wastes).	

Notes:

ARAR - applicable or relevant and appropriate requirement
BMP - best management practice
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
CFR - Code of Federal Regulations
EPA - U.S. Environmental Protection Agency
FR - Federal Register
LDR - land disposal restriction
MTR - minimum technology requirements for hazardous waste land disposal units
NPDES - National Pollutant Discharge Elimination System
ppm - parts per million
RCRA - Resource Conservation and Recovery Act
SPCC - spill prevention, control, and countermeasures
SWPPP - Stormwater Pollution Prevention Plan
USC - United States Code
ARAR status depends on the specific remedial alternatives evaluated. ARAR status will be reevaluated once the alternatives are determined.

TABLE 9

ENGINEERING SCORING SHEET

DECISION UNIT 1

Midway Atoll National Wildlife Refuge

Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
Overall Protection of Human Health and the Environment	0	0.5	0.5	0.5	0.5	0.5	0.5
Compliance with ARARs	0	0.25	0.5	0.5	0.5	0.5	0.75
Long Term Effectiveness and Permanence	0	0.5	0.75	0	1	0.75	0.25
Reduction of Toxicity, Mobility and Volume Through Treatment	0	0	0	0	0	0	0
Short Term Effectiveness	0	0.5	0.5	0.25	0.25	0.25	0.25
Implementability	1	0.5	0.5	0.5	0.25	0.5	0.25
Cost	1	0.5	0.5	0.5	0	0.5	0.25
Community Acceptance	0	0.5	0.5	0.5	0.5	0.5	0.5
Summary	2	3.25	3.75	2.75	3	3.5	2.75

Notes:

Alternative 1 - No Action

Alternative 2 - Abatement of lead from Building 643 and the demolition of the remaining structures with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the contaminated soils and demolition debris in the consolidation unit.

Alternative 3 - Abatement of lead from Building 643 and the demolition of the remaining structures with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the demolition debris and soil using ex-situ soil stabilization methods in a consolidation unit.

Alternative 4 – Abatement of lead from Building 643 and the demolition of the remaining structures and the installation of a geomembrane and soil cap. Onsite disposal of the demolition debris in the consolidation unit.

Alternative 5 – Abatement of lead from Building 643 and the demolition of the remaining structures with limited excavation and the installation of a geomembrane and a soil cap. Off-site disposal of the demolition debris and soil demolition debris in the consolidation unit.

Alternative 6 – Abatement of lead from Building 643 and the demolition of the remaining structures with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the building debris in the consolidation unit and on-site disposal of soils using ex-situ soil stabilization methods in a containment cell constructed near the Decision Unit.

Alternative 7 - Removal of structural members and abatement of lead from all cable buildings with limited excavation and the installation of a geomembrane and a soil cap.

Rating System:

Score of "1" - This alternative is the most favorable for this criterion compared to the other alternatives.

Score of "0.5" - This alternative is equal to other alternative.

Score of "0" - This alternative is the least favorable for this criterion compared to other alternatives.

Score of "0.25" or "0.75" - This alternative is slightly more favorable for this criterion compared to other alternatives.

ARRA = Applicable or relevant and appropriate requirement

TABLE 10

ENGINEERING SCORING SHEET

DECISION UNIT 2

Midway Atoll National Wildlife Refuge

Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Overall Protection of Human Health and the Environment	0	0.5	0.5	0.5	0.5
Compliance with ARARs	0	0.25	0.5	0.5	0.5
Long Term Effectiveness and Permanence	0	0.5	0.75	0	1
Reduction of Toxicity, Mobility and Volume Through Treatment	0	0	0	0	0
Short Term Effectiveness	0	0.5	0.5	0.25	0.25
Implementability	1	0.5	0.5	0.5	0.25
Cost	1	0.5	0.5	0.5	0
Community Acceptance	0	0.5	0.5	0.5	0.5
Summary	2	3.25	3.75	2.75	3

Notes:

Alternative 1 - No Action

Alternative 2 - Removal of asbestos transite siding and the demolition of the structures with excavation of contaminated soils. On-site disposal of the contaminated soils and demolition debris in a consolidation unit.

Alternative 3 - Removal of asbestos transite siding and the demolition of the structures with excavation of contaminated soils. On-site disposal of the demolition debris and soil using ex-situ soil stabilization methods in a consolidation unit.

Alternative 4 - Removal of asbestos transite siding and the demolition of the structures with the installation of a geomembrane and the capping of soils. Disposal of the demolition debris in the consolidation unit.

Alternative 5 – Removal of asbestos transite siding and the demolition of the structures with excavation of contaminated soils. Off-site disposal of the demolition debris and soil.

Rating System:

Score of "1" - This alternative is the most favorable for this criterion compared to the other alternatives.

Score of "0.5" - This alternative is equal to other alteratives.

Score of "0" - This alternative is the least favorable for this criterion compared to other alteratives.

Score of "0.25" or "0.75" - This alternative is slightly more favorable for this criterion compared to other alternatives.

ARRA = Applicable or relevant and appropriate requirement

TABLE 11

ENGINEERING SCORING SHEET

DECISION UNIT 3

Midway Atoll National Wildlife Refuge

Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Overall Protection of Human Health and the Environment	0	0.5	0.5	0.5	0.5
Compliance with ARARs	0	0.25	0.5	0.5	0.5
Long Term Effectiveness and Permanence	0	0.5	0.75	0	1
Reduction of Toxicity, Mobility and Volume Through Treatment	0	0	0	0	0
Short Term Effectiveness	0	0.5	0.5	0.25	0.25
Implementability	1	0.5	0.5	0.5	0.25
Cost	1	0.5	0.5	0.5	0
Community Acceptance	0	0.5	0.5	0.5	0.5
Summary	2	3.25	3.75	2.75	3

Notes:

Alternative 1 - No Action

Alternative 2 - Abatement of lead for the exterior of Building 4203 and 4212 with excavation of contaminated soils above the PCG. On-site disposal of the contaminated soils in a lined consolidation unit.

Alternative 3 - Abatement of lead for the exterior of Building 4203 and 4212 with excavation of contaminated soils above the PCG. On-site disposal using ex-situ stabilization methods in a consolidation unit.

Alternative 4 – Abatement of lead for the exterior of Building 4203 and 4212 with the installation of a geomembrane and the capping of the soils.

Alternative 5 – Abatement of lead on the exterior of Buildings 4203 and 4212 with excavation of soils with lead at concentrations above the PCG. Off-site disposal of the contaminated soils.

Rating System:

Score of "1" - This alternative is the most favorable for this criterion compared to the other alternatives.

Score of "0.5" - This alternative is equal to other alternatives.

Score of "0" - This alternative is the least favorable for this criterion compared to other alternatives.

Score of "0.25" or "0.75" - This alternative is slightly more favorable for this criterion compared to other alternatives.

ARRA = Applicable or relevant and appropriate requirement

PCG = Preliminary cleanup goals

TABLE 12

ENGINEERING SCORING SHEET

DECISION UNIT 4

Midway Atoll National Wildlife Refuge

Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Overall Protection of Human Health and the Environment	0	0.5	0.5	0.5	0.5
Compliance with ARARs	0	0.25	0.5	0.5	0.5
Long Term Effectiveness and Permanence	0	0.5	0.75	0	1
Reduction of Toxicity, Mobility and Volume Through Treatment	0	0	0	0	0
Short Term Effectiveness	0	0.5	0.5	0.25	0.25
Implementability	1	0.5	0.5	0.5	0.25
Cost	1	0.5	0.5	0.5	0
Community Acceptance	0	0.5	0.5	0.5	0.5
Summary	2	3.25	3.75	2.75	3

Notes:

Alternative 1 - No Action

Alternative 2 - Abatement of lead for the exterior of Building 259, 2403, and 2404 with the excavation of soils above the PCG. On-site disposal of the contaminated soils in the consolidation unit.

Alternative 3 - Abatement of lead for the exterior of Building 259, 2403, 2404 with excavation of soils above the PCG. On-site disposal using ex-situ stabilization methods in a consolidation unit.

Alternative 4 – Abatement of lead for the exterior of Building 259, 2403, 2404 with the installation of a geomembrane and soil cap.

Alternative 5 – Abatement of lead for the exterior of Building 259, 2403, and 2404 with excavation of soils with lead at concentrations above the PCG. Off-site disposal of soil.

Rating System:

Score of "1" - This alternative is the most favorable for this criterion compared to the other alternatives.

Score of "0.5" - This alternative is equal to other alternatives.

Score of "0" - This alternative is the least favorable for this criterion compared to other alternatives.

Score of "0.25" or "0.75" - This alternative is slightly more favorable for this criterion compared to other alternatives.

ARRA = Applicable or relevant and appropriate requirement

PCG = Preliminary cleanup goals

TABLE 13

ENGINEERING SCORING SHEET

DECISION UNIT 5

Midway Atoll National Wildlife Refuge

Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Overall Protection of Human Health and the Environment	0	0.5	0.5	0.5	0.5
Compliance with ARARs	0	0.25	0.5	0.5	0.5
Long Term Effectiveness and Permanence	0	0.5	0.75	0	1
Reduction of Toxicity, Mobility and Volume Through Treatment	0	0	0	0	0
Short Term Effectiveness	0	0.5	0.5	0.25	0.25
Implementability	1	0.5	0.5	0.5	0.25
Cost	1	0.5	0.5	0.5	0
Community Acceptance	0	0.5	0.5	0.5	0.5
Summary	2	3.25	3.75	2.75	3

Notes:

Alternative 1 - No Action

Alternative 2 - Abatement of lead for the exterior of Building 5309 and 5303 with the excavation of soils above the PCG. On-site disposal of the contaminated soils in the consolidation unit.

Alternative 3 - Abatement of lead for the exterior of Building 5309 and 5303 with excavation of soils above the PCG. On-site disposal using ex-situ stabilization methods in a consolidation unit.

Alternative 4 – Abatement of lead for the exterior of Building 5309 and 5303 with the installation of a geomembrane and soil cap.

Alternative 5 – Abatement of lead for the exterior of Building 5309 and 5303 with excavation of soils above the PCG. Off-site disposal of soil.

Rating System:

Score of "1" - This alternative is the most favorable for this criterion compared to the other alternatives.

Score of "0.5" - This alternative is equal to other alteratives.

Score of "0" - This alternative is the least favorable for this criterion compared to other alteratives.

Score of "0.25" or "0.75" - This alternative is slightly more favorable for this criterion compared to other alternatives.

ARRA = Applicable or relevant and appropriate requirement

PCG = Preliminary cleanup goals

TABLE 14

ENGINEERING SCORING SHEET

DECISION UNIT 6

Midway Atoll National Wildlife Refuge

Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Overall Protection of Human Health and the Environment	0	0.5	0.5	0.5	0.5	0.5
Compliance with ARARs	0	0.5	0.5	0.5	0.5	0.5
Long Term Effectiveness and Permanence	0	0.5	0.5	0	1	0.75
Reduction of Toxicity, Mobility and Volume Through Treatment	0	0	0	0	0	0
Short Term Effectiveness	0	0.5	0.5	0.5	0	0.25
Implementability	1	0.5	0.5	0.5	0	0.5
Cost	1	0.5	0.5	0.5	0	0.5
Community Acceptance	0	0.5	0.5	0.5	0.5	0.5
Summary	2	3.5	3.5	3	2.5	3.5

Notes:

Alternative 1 - No Action

Alternative 2 - Abatement of lead for the exterior the buildings with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the contaminated soils in the consolidation unit.

Alternative 3 - Abatement of lead for the exterior of the buildings with limited excavation of soils with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal using ex-situ stabilization methods in a consolidation unit.

Alternative 4 – Abatement of lead for the exterior of the buildings and the installation of a geomembrane and soil cap.

Alternative 5 – Abatement of lead on the exterior of the buildings with limited excavation of soils and the installation of a geomembrane and a soil cap. Off-site disposal of the soil.

Alternative 6 – Abatement of lead on the exterior of the buildings with limited excavation of soils and the installation of a geomembrane and a soil cap. On-site disposal of the soils using ex-site soil stabilization methods in a containment cell constructed near the Decision Unit.

Rating System:

Score of "1" - This alternative is the most favorable for this criterion compared to the other alternatives.

Score of "0.5" - This alternative is equal to other alternatives.

Score of "0" - This alternative is the least favorable for this criterion compared to other alternatives.

Score of "0.25" or "0.75" - This alternative is slightly more favorable for this criterion compared to other alternatives.

ARRA = Applicable or relevant and appropriate requirement

TABLE 15

ENGINEERING SCORING SHEET

DECISION UNIT 7

Midway Atoll National Wildlife Refuge

Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Overall Protection of Human Health and the Environment	0	0.5	0.5	0.5	0.5
Compliance with ARARs	0	0.25	0.5	0.5	0.5
Long Term Effectiveness and Permanence	0	0.5	0.75	0	1
Reduction of Toxicity, Mobility and Volume Through Treatment	0	0	0	0	0
Short Term Effectiveness	0	0.5	0.5	0.25	0.25
Implementability	1	0.5	0.5	0.5	0.25
Cost	1	0.5	0.5	0.5	0
Community Acceptance	0	0.5	0.5	0.5	0.5
Summary	2	3.25	3.75	2.75	3

Notes:

Alternative 1 - No Action

Alternative 2 - Abatement of lead for the exterior the buildings with the excavation of soils above the PCG. On-site disposal of the contaminated soils in the consolidation unit

Alternative 3 - Abatement of lead for the exterior of the buildings with excavation of soils above the PCG. On-site disposal using ex-situ stabilization methods in a consolidation unit

Alternative 4 – Abatement of lead for the exterior of the buildings with the installation of a geomembrane and soil cap

Alternative 5 – Abatement of lead for the exterior of the buildings and excavation of soils above the PCG. Off-site disposal of soils.

Rating System:

Score of "1" - This alternative is the most favorable for this criterion compared to the other alternatives.

Score of "0.5" - This alternative is equal to other alternatives.

Score of "0" - This alternative is the least favorable for this criterion compared to other alternatives.

Score of "0.25" or "0.75" - This alternative is slightly more favorable for this criterion compared to other alternatives.

ARRA = Applicable or relevant and appropriate requirement

PCG = Preliminary cleanup goals

TABLE 16

ENGINEERING SCORING SHEET

DECISION UNIT 8

Midway Atoll National Wildlife Refuge

Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Overall Protection of Human Health and the Environment	0	0.5	0.5	0.5	0.5
Compliance with ARARs	0	0.25	0.5	0.5	0.5
Long Term Effectiveness and Permanence	0	0.5	0.75	0	1
Reduction of Toxicity, Mobility and Volume Through Treatment	0	0	0	0	0
Short Term Effectiveness	0	0.5	0.5	0.25	0.25
Implementability	1	0.5	0.5	0.5	0.25
Cost	1	0.5	0.5	0.5	0
Community Acceptance	0	0.5	0.5	0.5	0.5
Summary	2	3.25	3.75	2.75	3

Notes:

Alternative 1 - No Action

Alternative 2 - Decommissioning of each AST by removal with excavation of soils from the Decision Unit. On-site disposal of the contaminated soils in a lined consolidation unit

Alternative 3 - Decommissioning of each AST by removal with excavation of soils from the Decision Unit. On-site disposal using ex-situ stabilization methods in a consolidation unit

Alternative 4 – Decommissioning of each ASTs by removal with placement of a geomembrane and capping of the soils

Alternative 5 – Decommissioning of each AST by removal with excavation of soils from the Decision Unit. Off-site disposal of soils.

Rating System:

Score of "1" - This alternative is the most favorable for this criterion compared to the other alternatives.

Score of "0.5" - This alternative is equal to other alternatives.

Score of "0" - This alternative is the least favorable for this criterion compared to other alternatives.

Score of "0.25" or "0.75" - This alternative is slightly more favorable for this criterion compared to other alternatives.

ARRA = Applicable or relevant and appropriate requirement

TABLE 17

ENGINEERING SCORING SHEET

DECISION UNIT 9

Midway Atoll National Wildlife Refuge

Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Overall Protection of Human Health and the Environment	0	0.5	0.5	0.5	0.5
Compliance with ARARs	0	0.25	0.5	0.5	0.5
Long Term Effectiveness and Permanence	0	0.5	0.75	0	1
Reduction of Toxicity, Mobility and Volume Through Treatment	0	0	0	0	0
Short Term Effectiveness	0	0.5	0.5	0.25	0.25
Implementability	1	0.5	0.5	0.5	0.25
Cost	1	0.5	0.5	0.5	0
Community Acceptance	0	0.5	0.5	0.5	0.5
Summary	2	3.25	3.75	2.75	3

Notes:

Alternative 1 - No Action

Alternative 2 - Abatement of lead for the exterior of the structures with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the contaminated soils in the consolidation unit.

Alternative 3 - Abatement of lead for the exterior of the structures with limited excavation of soils with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal using ex-situ stabilization methods in a consolidation unit.

Alternative 5 – Abatement of lead for the exterior of the structures with limited excavation and the installation of a geomembrane and a soil cap. Off-site disposal of the contaminated soils.

Alternative 4 – Abatement of lead for the exterior of the structures and the installation of a geomembrane and soil cap.

Rating System:

Score of "1" - This alternative is the most favorable for this criterion compared to the other alternatives.

Score of "0.5" - This alternative is equal to other alternatives.

Score of "0" - This alternative is the least favorable for this criterion compared to other alternatives.

Score of "0.25" or "0.75" - This alternative is slightly more favorable for this criterion compared to other alternatives.

ARRA = Applicable or relevant and appropriate requirement

TABLE 18

ENGINEERING ESTIMATE - SHARED COSTS

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Project Design					
Preparation of project plans	ls	1	$75,000	$75,000	Preparation of Removal Action Work Plan, Sampling and Analysis Plan, Quality Assurance Project Plan, Health and Safety Plan, Stormwater Pollution Prevention Plan and updating the site Spill Prevention Plan.
Equipment and Supplies					
Procure, prepare and load field supplies	ls	1	$12,000	$12,000	Conservative estimate.
Mobilization of supplies from CONUS to Honolulu, Hawaii	ls	1	$25,000	$25,000	Conservative estimate.
Rental of transport vessel for initial field supplies	ls	1	$200,000	$200,000	M/V Kahana from Honolulu Marine. Assumes dedicated trip for delivery of shared field supplies.
Purchase of used 10-15 yard dump truck	ea	2	$100,000	$200,000	Vendor Estimate from Cummings West of Honolulu, Hawaii.
Supply container purchase	ea	20	$3,000	$60,000	Assumes 5 containers for storage of field supplies and 15 containers for hazardous materials storage. Due to duration of project, purchase price is less than rental.
XRF purchase	ls	1	$40,000	$40,000	Assumes FWS will purchase a new XRF for dedicated use for duration of Midway project work. Purchase price is less than 5 year rental period with numerous shipping requirements.
55-gallon drums	ea	200	$50	$10,000	Purchase of 55-gallon drums for lead abatement work.
Asbestos abatement supplies	ls	1	$40,000	$40,000	Conservative estimate. Includes the purchase of disposal bags, containers and field supplies (breaker bars, plastic sheeting, etc).
Lead abatement supplies	ls	1	$55,000	$55,000	Conservative estimate. Assumes the purchase of lead abatement supplies including plastic sheeting, scaffolding, filters, plywood, hand tools, PPE, power tools, etc.
Equipment repair and maintenance costs	yr	5	$12,000	$60,000	Conservative estimate. Assumes routine maintenance and repairs of equipment by FWS and onsite personnel.
Rental of transport vessel for disposal of ACM and LBP waste	ls	1	$200,000	$200,000	M/V Kahana from Honolulu Marine. Assumes dedicated trip for transportation of LBP and ACM debris to Honolulu, Hawaii.
Transport of existing LBP and ACM to CONUS	ls	1	$50,000	$50,000	Based on existing LBP and ACM inventory.
Disposal of existing LBP and ACM in CONUS	ls	1	$100,000	$100,000	Based on existing LBP and ACM inventory.
			Subtotal	$977,000	
			15% Contingency	$146,550	
			TASK SUBTOTAL	**$1,123,550**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

ls = lump sum
cy = cubic yard
yr = year
ea = each
FWS = Fish and Wildlife Services
PPE - personal protection equipment
LBP = lead-based paint
ACM = asbestos-containing material

TABLE 19

ENGINEERING ESTIMATE - SHARED COSTS FOR HDPE CONSOLIDATION UNIT ALTERNATIVES

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - liner installation crew for consolidation unit	ea	2	$3,450	$6,900	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Midway lodging per diem	ea	6	$125	$750	Assumes 6 days to complete work for 2 workers. Two crew per room for lodging.
Midway meals per diem	ea	12	$50	$600	Assumes 6 days to complete work for 2 workers.
Construction crew labor to prepare R2 Unit for debris	hr	240	$80	$19,200	Assumes the construction crew will take 5 days to prepare R2 for debris placement.
Liner installation crew labor	hr	80	$85	$6,800	Assumes 5 days to install liner at consolidation unit.
Site supervisor labor	hr	64	$100	$6,400	Assumes 3 days to oversee liner installation and 5 days to oversee the preparation of the R2 Unit.
Excavation and demolition crew labor to assist in consolidation liner placement	hr	144	$80	$11,520	Assumes the demolition crew will take 3 days to assist in the placement of the consolidation liner.
On-island equipment rental	day	5	$3,000	$15,000	Rental of 10 yard dump truck, track hoe excavator, backhoe and other heavy equipment from FWS.
Consolidation unit fasteners and supports	ls	1	$25,000	$25,000	Conservative estimate.
Consolidation unit liner costs	sf	90,190	$0.40	$36,076	Assumes the 60-mil HDPE liner will be placed on the top of the R2 after digging is complete. Size of the unit is 311 feet by 232 feet with a 25% safety factor for fitting the liner.
			Subtotal	$131,696	
			15% Contingency	$19,754	
			TASK SUBTOTAL	**$151,450**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

ls = lump sum
sf = square foot
hr = hour
ea = each
FWS = Fish and Wildlife Services
HDPE = high density polyethylene
CONUS = Continental United States

TABLE 20

ENGINEERING ESTIMATE - SHARED COSTS FOR SOLIDIFICATION CONSOLIDATION UNIT ALTERNATIVES

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Stabilization Consolidation Unit Construction Costs					
Construction crew labor to prepare R2 Unit for debris	hr	240	$80	$19,200	Assumes the construction crew will take 5 days to prepare R2 for debris placement.
Site supervisor labor	hr	40	$100	$4,000	Assumes 5 days to oversee the preparation of the R2 Unit.
On-island equipment rental	day	5	$3,000	$15,000	Rental of 10 yard dump truck, track hoe excavator, backhoe and other heavy equipment from FWS.
Rental of transport vessel for Portland Cement	ls	1	$200,000	$200,000	M/V Kahana from Honolulu Marine. Assumes dedicated trip for delivery of shared field supplies.
Purchase of Portland Cement	ton	1,500	$20	$30,000	Assumes up to 1,500 tons of Portland cement will be needed.
Purchase of a 12 foot wide disker with 28-inch disks	ls	1	$40,000	$40,000	Conservative estimate.
			Subtotal	$308,200	
			15% Contingency	$46,230	
			TASK SUBTOTAL	**$354,430**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
FWS = Fish and Wildlife Services
HDPE = high density polyethylene
CONUS = Continental United States

TABLE 21

ENGINEERING ESTIMATE - SHARED COSTS FOR OFFSITE DISPOSAL ALTERNATIVES

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Construction crew labor to prepare temporary staging area near Seaplane Hangar	hr	672	$80	$53,760	Assumes 14 days to prepare staging area.
Site supervisor labor	hr	112	$100	$11,200	Assumes 14 days to oversee the installation of the temporary storage area.
On-island equipment rental	day	34	$3,000	$102,000	Rental of 10 yard dump truck, track hoe excavator, backhoe and other heavy equipment from FWS. Rates assume time for building of staging area and loading barge (2 times).
Consolidation unit liner costs	sf	150,000	$0.40	$60,000	Assumes the 60-mil HDPE liner will be placed on the bottom and also on top of the staging stockpile.
14,000 ton waste disposal barge and support tug	ea	2	$800,000.00	$1,600,000	Rental of tug and barge from CONUS to Midway and back to CONUS.
Barge and tug standby charges while loading	day	30	$30,000.00	$900,000	Assumes 15 days per load out (2 total). Assumes 2 barges will be needed to haul out ~28,000 tons of soil and builidng debris
Construction crew labor to prepare the barge for bulk soil loading	hr	480	$80.00	$38,400	Assumes 5 days per trip (2 total) to prepare barge for bulk loading.
Construction crew labor to transfer staged material to barge	hr	960	$80.00	$76,800	Assumes 10 days to load each barge. Two total.
Site supervisor labor	hr	240	$100.00	$24,000	Assumes 15 days to preprare barge and load barge. Two total.
			Subtotal	$2,869,610	
			15% Contingency	$430,442	
			TASK SUBTOTAL	**$3,300,052**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

ls = lump sum
sf = square foot
hr = hour
ea = each
FWS = Fish and Wildlife Services
HDPE = high density polyethylene
CONUS = Continental United States

TABLE 22

ENGINEERING ESTIMATE - DECISION UNIT 1

ALTERNATIVE 2 - Abatement of lead from Building 643 and the demolition of the remaining structures with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the contaminated soils and demolition debris in the consolidation unit.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using the HDPE liner cap for the consolidation unit	ls	1	$16,660	$16,660	Includes 11 percent of the shared project costs listed on Table 19 (costs split between the nine Decision Units).
			Subtotal	**$140,250**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - painting crew	ea	3	$3,450	$10,350	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$58,650**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	480	$80	$38,400	Assumes 10 days to abate the 25,000 square feet of loose and flaky lead based paint from exterior of Building 643.
ACM crew labor	hr	576	$80	$46,080	Assumes 12 days to abate all ACM from building 643, other structures set for demolition are not included due to the unsafe conditions to structures. Other buildings will be demolished with non-friable asbestos in place.
Excavation and demolition crew labor	hr	280	$80	$22,400	Demolition of existing structures and transport to consolidation unit. Assumes 5 days to complete the demolition and hauling of debris.
Excavation and demolition crew labor	hr	224	$80	$17,920	Excavation of contaminated soils. Assumes the removal of 3,500 cubic yards of soil will take 4 days to complete.
Excavation and demolition crew labor	hr	672	$80	$53,760	Placement of geotextile and backfilling of excavation. Assumes the backfilling of the excavation with 10,500 cubic yards will take 12 days to complete.
Paint crew labor	hr	120	$75	$9,000	Assumes 5 days to paint Building 643.
Site supervisor labor	hr	490	$100	$49,000	Assumes 49 days to complete work at Decision Unit 1.
Midway lodging per diem	ea	172	$125	$21,500	Assumes two crew per room for lodging.
Midway meals per diem	ea	343	$50	$17,150	
			Subtotal	**$275,210**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	40	$2,000	$80,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	50	$35	$1,750	Cost of paint for Building 643 with EcoBond by MT2.
Excavation area liner costs	sf	38,000	$0.32	$12,160	Assumes the lining of an area 50 feet out from each building footprint in the Decision Unit.
Total Lead in soil testing	ea	25	$7	$175	Confirmation sampling to verify XRF field data.
			Subtotal	**$94,085**	
Disposal Costs					
Disposal of LBP	ea	4	$800	$3,200	Assumes the generation of 4 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
Disposal of ACM	ea	2	$17,000	$34,000	Assumes the generation of 2 containers of ACM. Also assumes ACM can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$37,200**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$35,000	$35,000	Assumes approximately 5% of the estimated project total without contingency
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$55,000**	
			Project Subtotal	$703,728	
			15% Contingency	$105,559	
			DECISION UNIT 1 - ALTERNATIVE 2 TOTAL	**$809,288**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 23

ENGINEERING ESTIMATE - DECISION UNIT 1

ALTERNATIVE 3 - Abatement of lead from Building 643 and the demolition of the remaining structures with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the demolition debris and soil using ex-situ soil stabilization methods in a consolidation unit.

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Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using solidification at the consolidation unit	ls	1	$38,987	$38,987	Includes 11 percent of the shared project costs listed on Table 20 (costs split between the nine Decision Units).
			Subtotal	**$162,578**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - painting crew	ea	3	$3,450	$10,350	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$58,650**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	480	$80	$38,400	Assumes 10 days to abate the 25,000 square feet of loose and flaky lead based paint from exterior of Building 643.
ACM crew labor	hr	576	$80	$46,080	Assumes 12 days to abate all ACM from building 643, other structures set for demolition are not included due to the unsafe conditions to structures. Other buildings will be demolished with non-friable asbestos in place.
Excavation and demolition crew labor	hr	280	$80	$22,400	Demolition of existing structures and transport to consolidation unit. Assumes 5 days to complete the demolition and hauling of debris.
Excavation and demolition crew labor	hr	224	$80	$17,920	Excavation of contaminated soils. Assumes the removal of 3,500 cubic yards of soil will take 4 days to complete.
Excavation and demolition crew labor	hr	168	$80	$13,440	Placement of excavated materials and debris in consolidation unit and implementing the solidification process. Assumes 3 days to complete.
Excavation and demolition crew labor	hr	672	$80	$53,760	Placement of geotextile and backfilling of excavation. Assumes the backfilling of the excavation with 10,500 cubic yards will take 12 days to complete.
Paint crew labor	hr	120	$75	$9,000	Assumes 5 days to paint Building 643.
Site supervisor labor	hr	490	$100	$49,000	Assumes 49 days to complete work at Decision Unit 1.
Midway lodging per diem	ea	172	$125	$21,500	Assumes two crew per room for lodging.
Midway meals per diem	ea	343	$50	$17,150	
			Subtotal	**$288,650**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	40	$2,000.00	$80,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	50	$35.00	$1,750	Cost of paint for Building 643 with EcoBond by MT2.
Excavation area liner costs	sf	38,000	$0.32	$12,160	Assumes the lining of an area 50 feet out from each building footprint in the Decision Unit.
Total Lead in soil testing	ea	25	$7.00	$175	Confirmation sampling to verify XRF field data.
			Subtotal	**$94,085**	
Disposal Costs					
Disposal of LBP	ea	4	$800	$3,200	Assumes the generation of 4 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
Disposal of ACM	ea	2	$17,000	$34,000	Assumes the generation of 2 containers of ACM. Also assumes ACM can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$37,200**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000.00	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000.00	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$37,250	$37,250	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$57,250**	
			Project Subtotal	$741,746	
			15% Contingency	$111,262	
			DECISION UNIT 1 - ALTERNATIVE 3 TOTAL	**$853,008**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 24

ENGINEERING ESTIMATE - DECISION UNIT 1

ALTERNATIVE 4 - Abatement of lead from Building 643 and the demolition of the remaining structures and the installation of a geomembrane and soil cap. On-site disposal of the demolition debris in the consolidation unit.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
			Subtotal	**$123,591**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - painting crew	ea	3	$3,450	$10,350	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$58,650**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	480	$80	$38,400	Assumes 10 days to abate the 25,000 square feet of loose and flaky lead based paint from exterior of Building 643.
ACM crew labor	hr	576	$80	$46,080	Assumes 12 days to abate all ACM from building 643, other structures set for demolition are not included due to the unsafe conditions to structures. Other buildings will be demolished with non-friable asbestos in place.
Excavation and demolition crew labor	hr	280	$80	$22,400	Demolition of existing structures and transport to consolidation unit. Assumes 5 days to complete the demolition and hauling of debris.
Excavation and demolition crew labor	hr	672	$80	$53,760	Placement of geotextile and placement of cap. Assumes the placement of 10,500 cubic yard cap will take 12 days to complete.
Paint crew labor	hr	120	$70	$8,400	Assumes 5 days to paint Building 643.
Site supervisor labor	hr	440	$100	$44,000	Assumes 44 days to complete work at Decision Unit 1.
Midway lodging per diem	ea	147	$125	$18,375	Assumes two crew per room for lodging.
Midway meals per diem	ea	294	$50	$14,700	
			Subtotal	**$246,115**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	44	$2,000	$88,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	50	$35	$1,750	Cost of paint for Building 643.
Excavation area liner costs	sf	38,000	$0.32	$12,160	Assumes the lining of an area 50 feet out from each building footprint in the Decision Unit.
Total Lead in soil testing	ea	25	$7	$175	Confirmation sampling to verify XRF field data.
			Subtotal	**$102,085**	
Disposal Costs					
Disposal of LBP	ea	4	$800	$3,200	Assumes the generation of 4 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
Disposal of ACM	ea	2	$17,000	$34,000	Assumes the generation of 2 containers of ACM. Also assumes ACM can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal or potentially Oahu for disposal.
			Subtotal	**$37,200**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$33,250.00	$33,250	Assumes approximately 5% of the estimated project total without contingency
Closeout report	ls	1	$20,000.00	$20,000	
			Subtotal	**$53,250**	
			Project Subtotal	$664,224	
			15% Contingency	$99,634	
			DECISION UNIT 1 - ALTERNATIVE 4 TOTAL	**$763,857**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 25

ENGINEERING ESTIMATE - DECISION UNIT 1

ALTERNATIVE 5 - Abatement of lead from Building 643 and the demolition of the remaining structures with limited excavation and the installation of a geomembrane and a soil cap. Off-site disposal of the demolition debris and soil.

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Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using off-site disposal	ls	1	$363,006	$363,006	Includes 11 percent of the shared project costs listed on Table 21 (costs split between the nine Decision Units).
			Subtotal	**$486,596**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - painting crew	ea	3	$3,450	$10,350	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$58,650**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	480	$80	$38,400	Assumes 10 days to abate the 25,000 square feet of loose and flaky lead based paint from exterior of Building 643.
ACM crew labor	hr	576	$80	$46,080	Assumes 12 days to abate all ACM from building 643, other structures set for demolition are not included due to the unsafe conditions to structures. Other buildings will be demolished with non-friable asbestos in place.
Excavation and demolition crew labor	hr	336	$80	$26,880	Demolition of existing structures and transport to staging area near Seaplane Hangar. Assumes 6 days to complete the demolition and hauling of debris.
Excavation and demolition crew labor	hr	224	$80	$17,920	Excavation of contaminated soils. Assumes the removal of 3,500 cubic yards of soil will take 4 days to complete.
Excavation and demolition crew labor	hr	168	$80	$13,440	Placement of excavated materials and debris in staging area. Assumes 3 days to complete.
Excavation and demolition crew labor	hr	672	$80	$53,760	Placement of geotextile and backfilling of excavation. Assumes the backfilling of the excavation with 10,500 cubic yards will take 12 days to complete.
Paint crew labor	hr	120	$75	$9,000	Assumes 5 days to paint Building 643.
Site supervisor labor	hr	500	$100	$50,000	Assumes 50 days to complete work at Decision Unit 1.
Midway lodging per diem	ea	172	$125	$21,500	Assumes two crew per room for lodging.
Midway meals per diem	ea	343	$50	$17,150	
			Subtotal	**$294,130**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	42	$2,000.00	$84,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	50	$35.00	$1,750	Cost of paint for Building 643 with EcoBond by MT2.
Excavation area liner costs	sf	38,000	$0.32	$12,160	Assumes the lining of an area 50 feet out from each building footprint in the Decision Unit.
Total Lead in soil testing	ea	25	$7.00	$175	Confirmation sampling to verify XRF field data.
			Subtotal	**$98,085**	
Disposal Costs					
Disposal of LBP	ea	4	$800	$3,200	Assumes the generation of 4 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
Disposal of ACM	ea	2	$17,000	$34,000	Assumes the generation of 2 containers of ACM. Also assumes ACM can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
Disposal of demolition debris and soil in CONUS	ton	8,540	$50	$427,000	Assumes a 1.4 cubic yard per ton conversion. Assumed 3,500 cubic yards of soil and 2,600 cubic yards of demolition debris.
			Subtotal	**$37,200**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000.00	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000.00	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$53,750	$53,750	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$73,750**	
			Project Subtotal	$1,091,744	
			15% Contingency	$163,762	
			DECISION UNIT 1 - ALTERNATIVE 5 TOTAL	**$1,255,506**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 26

ENGINEERING ESTIMATE - DECISION UNIT 1

ALTERNATIVE 6 - Abatement of lead from Building 643 and the demolition of the remaining structures with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the building debris in the consolidation unit and on-site disposal of soils using ex-situ soil stabilization methods in a containment cell constructed near the Decision Unit.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
			Subtotal	**$123,591**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - painting crew	ea	3	$3,450	$10,350	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$58,650**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	480	$80	$38,400	Assumes 10 days to abate the 25,000 square feet of loose and flaky lead based paint from exterior of Building 643.
ACM crew labor	hr	576	$80	$46,080	Assumes 12 days to abate all ACM from building 643, other structures set for demolition are not included due to the unsafe conditions to structures. Other buildings will be demolished with non-friable asbestos in place.
Excavation and demolition crew labor	hr	280	$80	$22,400	Demolition of existing structures and transport to consolidation unit. Assumes 5 days to complete the demolition and hauling of debris.
Excavation and demolition crew labor	hr	224	$80	$17,920	Excavation of contaminated soils. Assumes the removal of 3,500 cubic yards of soil will take 4 days to complete.
Excavation and demolition crew labor	hr	840	$80	$67,200	Excavation of containment cell near Decision Unit. Excvaation will be ~10,500 cubic yards in size. Assumes the excavation and backfilling of the contaminated soil excavation will take 15 days to complete. Backfilling of excavation left by contaminated soil will be completed at the same time.
Excavation and demolition crew labor	hr	56	$80	$4,480	Placement of debris in consolidation unit. Assumes 1 days to complete.
Excavation and demolition crew labor	hr	560	$80	$44,800	Placement of contaminated soil in consolidation using ex-situ stabilization and capping with clean soil. Assumes the backfilling of the excavation with 3,500 cubic yards of contaminated soil and clean soil will take 10 days to complete.
Paint crew labor	hr	120	$75	$9,000	Assumes 5 days to paint Building 643.
Site supervisor labor	hr	570	$100	$57,000	Assumes 57 days to complete work at Decision Unit 1.
Midway lodging per diem	ea	215	$125	$26,875	Assumes two crew per room for lodging.
Midway meals per diem	ea	430	$50	$21,500	
			Subtotal	**$355,655**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	50	$2,000.00	$100,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	50	$35.00	$1,750	Cost of paint for Building 643 with EcoBond by MT2.
Excavation area liner costs	sf	38,000	$0.32	$12,160	Assumes the lining of an area 50 feet out from each building footprint in the Decision Unit.
Total Lead in soil testing	ea	25	$7.00	$175	Confirmation sampling to verify XRF field data.
			Subtotal	**$114,085**	
Disposal Costs					
Disposal of LBP	ea	4	$800	$3,200	Assumes the generation of 4 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
Disposal of ACM	ea	2	$17,000	$34,000	Assumes the generation of 2 containers of ACM. Also assumes ACM can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$37,200**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000.00	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000.00	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$37,250	$37,250	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$57,250**	
			Project Subtotal	$789,764	
			15% Contingency	$118,465	
			DECISION UNIT 1 - ALTERNATIVE 6 TOTAL	**$908,228**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 27

ENGINEERING ESTIMATE - DECISION UNIT 2

ALTERNATIVE 2 – Removal of asbestos transite siding and the demolition of the structures with excavation of contaminated soils. On-site disposal of the contaminated soils and demolition debris in a consolidation unit.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using the HDPE liner cap for the consolidation unit	ls	1	$16,660	$16,660	Includes 11 percent of the shared project costs listed on Table 19 (costs split between the nine Decision Units).
			Subtotal	**$140,250**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	12	$3,450	$41,400	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$69,000**	
Field Activities - Project Crew Costs					
ACM crew labor	hr	3,552	$80	$284,160	Assumes 30 days to abate all ACM and 7 days to remove loose & flaky paint (exterior surfaces) from structures set for demolition.
Excavation and demolition crew labor	hr	280	$80	$22,400	Demolition of existing structures and transport to consolidation unit. Assumes 5 days to complete the demolition and hauling of debris.
Excavation and demolition crew labor	hr	112	$80	$8,960	Excavation of contaminated soils. Assumes the removal of 1,400 cubic yards of soil will take 2 days to complete.
Excavation and demolition crew labor	hr	112	$80	$8,960	Backfilling of excavation. Assumes the backfilling of the excavation with 1,400 cubic yards will take 2 days to complete.
Site supervisor labor	hr	460	$100	$46,000	Assumes 46 days to complete work at Decision Unit 2.
Midway lodging per diem	ea	277	$125	$34,625	Two crew per room for lodging.
Midway meals per diem	ea	553	$50	$27,650	
			Subtotal	**$432,755**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	46	$2,000	$92,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Total Lead in soil testing	ea	25	$7	$175	Confirmation sampling to verify XRF field data.
			Subtotal	**$92,175**	
Disposal Costs					
Disposal of LBP	ea	5	$800	$4,000	Assumes the generation of 5 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
Disposal of ACM	ea	14	$17,000	$238,000	Assumes the generation of 14 containers of ACM. Also assumes ACM can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$242,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$55,004	$55,004	Assumes approximately 5% of the estimated project total without contingency
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$75,004**	
			Project Subtotal	$1,094,517	
			15% Contingency	$164,178	
			DECISION UNIT 2 - ALTERNATIVE 2 TOTAL	**$1,258,695**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 28

ENGINEERING ESTIMATE - DECISION UNIT 2

ALTERNATIVE 3 – Removal of asbestos transite siding and the demolition of the structures with excavation of contaminated soils. On-site disposal of the demolition debris and soil using ex-situ soil stabilization methods in a consolidation unit.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using solidification at the consolidation unit	ls	1	$38,987	$38,987	Includes 11 percent of the shared project costs listed on Table 20 (costs split between the nine Decision Units).
			Subtotal	**$162,578**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	12	$3,450	$41,400	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$69,000**	
Field Activities - Project Crew Costs					
ACM crew labor	hr	3,552	$80	$284,160	Assumes 30 days to abate all ACM and 7 days to remove loose & flaky paint (exterior surfaces) from structures set for demolition.
Excavation and demolition crew labor	hr	280	$80	$22,400	Demolition of existing structures and transport to st. Assumes 5 dagys to complete the demolition and hauling of debris.
Excavation and demolition crew labor	hr	112	$80	$8,960	Excavation of contaminated soils. Assumes the removal of 1,400 cubic yards of soil will take 2 days to complete.
Excavation and demolition crew labor	hr	112	$80	$8,960	Placement of excavated materials and debris in consolidation unit and implementing the solidification process. Assumes 2 days to complete.
Excavation and demolition crew labor	hr	112	$80	$8,960	Backfilling of excavation. Assumes the backfilling of the excavation with 1,400 cubic yards will take 2 days to complete.
Site supervisor labor	hr	480	$100	$48,000	Assumes 48 days to complete work at Decision Unit 2.
Midway lodging per diem	ea	277	$125	$34,625	Two crew per room for lodging.
Midway meals per diem	ea	554	$50	$27,700	
			Subtotal	**$443,765**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	48	$2,000	$96,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Total Lead in soil testing	ea	25	$7	$175	Confirmation sampling to verify XRF field data.
			Subtotal	**$96,175**	
Disposal Costs					
Disposal of LBP	ea	5	$800	$4,000	Assumes the generation of 5 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
Disposal of ACM	ea	14	$17,000	$238,000	Assumes the generation of 14 containers of ACM. Also assumes ACM can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$242,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$57,250	$57,250	Assumes approximately 5% of the estimated project total without contingency
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$77,250**	
			Project Subtotal	$1,134,101	
			15% Contingency	$170,115	
			DECISION UNIT 2 - ALTERNATIVE 3 TOTAL	**$1,304,216**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 29

ENGINEERING ESTIMATE - DECISION UNIT 2

ALTERNATIVE 4 - Removal of asbestos transite siding and the demolition of the structures with the installation of a geomembrane and the capping of soils. Disposal of the demolition debris in the consolidation unit.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
			Subtotal	**$123,591**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	12	$3,450	$41,400	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$69,000**	
Field Activities - Project Crew Costs					
ACM crew labor	hr	3,552	$80	$284,160	Assumes 30 days to abate all ACM and 7 days to remove loose & flaky paint (exterior surfaces) from structures set for demolition.
Excavation and demolition crew labor	hr	280	$80	$22,400	Demolition of existing structures and transport to consolidation unit. Assumes 5 days to complete the demolition and hauling of debris.
Excavation and demolition crew labor	hr	336	$80	$26,880	Placement of geomembrane and placement of cap. Assumes the placement of the cap using 4,200 cubic yards will take 6 days to complete.
Site supervisor labor	hr	480	$100	$48,000	Assumes 48 days to complete work at Decision Unit 2.
Midway lodging per diem	ea	277	$125	$34,625	Two crew per room for lodging.
Midway meals per diem	ea	553	$50	$27,650	
			Subtotal	**$443,715**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	12	$2,000	$24,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Excavation area liner costs	sf	20,000	$0.32	$6,400	Assumes the lining of an area 50 feet out from each building footprint in the Decision Unit.
Total Lead in soil testing	ea	25	$7	$175	Confirmation sampling to verify XRF field data.
			Subtotal	**$30,575**	
Disposal Costs					
Disposal of LBP	ea	5	$800	$4,000	Assumes the generation of 5 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
Disposal of ACM	ea	14	$17,000	$238,000	Assumes the generation of 14 containers of ACM. Also assumes ACM can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$242,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$49,025	$49,025	Assumes approximately 5% of the estimated project total without contingency
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$69,025**	
			Project Subtotal	$1,021,239	
			15% Contingency	$153,186	
			DECISION UNIT 2 - ALTERNATIVE 4 TOTAL	**$1,174,425**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 30

ENGINEERING ESTIMATE - DECISION UNIT 2

ALTERNATIVE 5 - Removal of asbestos transite siding and the demolition of the structures with excavation of contaminated soils. Off-site disposal of the demolition debris and soil.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using off-site disposal	ls	1	$363,006	$363,006	Includes 11 percent of the shared project costs listed on Table 21 (costs split between the nine Decision Units).
			Subtotal	**$486,596**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	12	$3,450	$41,400	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$69,000**	
Field Activities - Project Crew Costs					
ACM crew labor	hr	3,552	$80	$284,160	Assumes 30 days to abate all ACM and 7 days to remove loose & flaky paint (exterior surfaces) from structures set for demolition.
Excavation and demolition crew labor	hr	280	$80	$22,400	Demolition of existing structures and transport to staging area near Seaplane Hangar. Assumes 5 days to complete the demolition and hauling of debris.
Excavation and demolition crew labor	hr	112	$80	$8,960	Excavation of contaminated soils. Assumes the removal of 1,400 cubic yards of soil will take 2 days to complete.
Excavation and demolition crew labor	hr	112	$80	$8,960	Backfilling of excavation. Assumes the backfilling of the excavation with 1,400 cubic yards will take 2 days to complete.
Site supervisor labor	hr	460	$100	$46,000	Assumes 46 days to complete work at Decision Unit 2.
Midway lodging per diem	ea	277	$125	$34,625	Two crew per room for lodging.
Midway meals per diem	ea	553	$50	$27,650	
			Subtotal	**$432,755**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	46	$2,000	$92,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Total Lead in soil testing	ea	25	$7	$175	Confirmation sampling to verify XRF field data.
			Subtotal	**$92,175**	
Disposal Costs					
Disposal of LBP	ea	5	$800	$4,000	Assumes the generation of 5 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
Disposal of demolition debris and soil in CONUS	ton	6,160	$50	$308,000	Assumes a 1.4 cubic yard per ton conversion. Assumed 1,400 cubic yards of soil and 3,000 cubic yards of demolition debris.
Disposal of ACM	ea	14	$17,000	$238,000	Assumes the generation of 14 containers of ACM. Also assumes ACM can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$550,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$87,000	$87,000	Assumes approximately 5% of the estimated project total without contingency
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$107,000**	
			Project Subtotal	$1,780,859	
			15% Contingency	$267,129	
			DECISION UNIT 2 - ALTERNATIVE 5 TOTAL	**$2,047,988**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 31

ENGINEERING ESTIMATE - DECISION UNIT 3

ALTERNATIVE 2 - Abatement of lead on the exterior of Buildings 4203 and 4212 with excavation of soils with lead at concentrations above the PCG. On-site disposal of the contaminated soils in a lined consolidation unit.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using the HDPE liner cap for the consolidation unit	ls	1	$16,660	$16,660	Includes 11 percent of the shared project costs listed on Table 19 (costs split between the nine Decision Units).
			Subtotal	**$140,250.04**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$48,300**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	960	$80	$76,800	Assumes 20 days to abate the loose and flaky paint from Building 4202 and Building 4212.
Excavation crew labor	hr	280	$80	$22,400	Excavation of contaminated soils. Assumes the removal of 2,000 cubic yards of soil will take 5 days to complete.
Excavation crew labor	hr	280	$80	$22,400	Backfilling of excavation. Assumes the backfilling of the excavation with 2,000 cubic yards will take 5 days to complete.
Paint crew labor	hr	240	$75	$18,000	Assumes 10 days to paint Buildings 4202 and 4212.
Site supervisor labor	hr	400	$100	$40,000	Assumes 40 days to complete work at Decision Unit 3.
Midway lodging per diem	ea	150	$125	$18,750	Two crew per room for lodging.
Midway meals per diem	ea	300	$50	$15,000	
			Subtotal	**$213,350**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	32	$2,000	$64,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Total Lead in soil testing	ea	25	$7	$175	Confirmation sampling to verify XRF field data.
Encapsulation paint costs	gal	55	$35	$1,925	Cost of paint of Buildings 4202 and 4212.
			Subtotal	**$66,100**	
Disposal Costs					
Disposal of LBP	ea	8	$800.00	$6,400	Assumes the generation of 8 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$6,400.00**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$29,200.00	$29,200	Assumes approximately 5% of the estimated project total without contingency
Closeout report	ls	1	$20,000.00	$20,000	
			Subtotal	**$49,200**	
			Project Subtotal	$566,933	
			15% Contingency	$85,040	
			DECISION UNIT 3 - ALTERNATIVE 2 TOTAL	**$651,973**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 32

ENGINEERING ESTIMATE - DECISION UNIT 3

ALTERNATIVE 3 – Abatement of lead on the exterior of Buildings 4203 and 4212 with excavation of soils with lead at concentrations above the PCG. On-site disposal using ex-situ stabilization methods in a consolidation unit.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using solidification at the consolidation unit	ls	1	$38,987	$38,987	Includes 11 percent of the shared project costs listed on Table 20 (costs split between the nine Decision Units).
			Subtotal	**$162,578**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$48,300**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	960	$80	$76,800	Assumes 20 days to abate the loose and flaky paint from Building 4202 and Building 4212.
Excavation crew labor	hr	280	$80	$22,400	Excavation of contaminated soils. Assumes the removal of 2,000 cubic yards of soil will take 5 days to complete.
Excavation crew labor	hr	280	$80	$22,400	Backfilling of excavation. Assumes the backfilling of the excavation with 2,000 cubic yards will take 5 days to complete.
Excavation and demolition crew labor	hr	168	$80	$13,440	Placement of excavated materials and debris in consolidation unit and implementing the solidification process. Assumes 3 days to complete.
Paint crew labor	hr	240	$75	$18,000	Assumes 10 days to paint Buildings 4202 and 4212.
Site supervisor labor	hr	430	$100	$43,000	Assumes 43 days to complete work at Decision Unit 3.
Midway lodging per diem	ea	152.5	$125	$19,063	Two crew per room for lodging.
Midway meals per diem	ea	305	$50	$15,250	
			Subtotal	**$230,353**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	43	$2,000	$86,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	55	$35	$1,925	Cost of paint for Buildings 4202 and 4212.
Total Lead in soil testing	ea	25	$7	$175	Confirmation sampling to verify XRF field data.
			Subtotal	**$88,100**	
Disposal Costs					
Disposal of LBP	ea	8	$800	$6,400	Assumes the generation of 8 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$6,400**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$38,515	$38,515	Assumes approximately 5% of the estimated project total without contingency
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$58,515**	
			Project Subtotal	$637,579	
			15% Contingency	$95,637	
			DECISION UNIT 3 - ALTERNATIVE 3 TOTAL	**$733,215**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 33

ENGINEERING ESTIMATE - DECISION UNIT 3

ALTERNATIVE 4 – Abatement of lead on the exterior of Building 4203 and 4212 with the installation of a geomembrane and the capping of the soils.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
			Subtotal	**$123,591**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$48,300**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	960	$80	$76,800	Assumes 20 days to abate the loose and flaky paint from Building 4202 and Building 4212.
Excavation crew labor	hr	672	$80	$53,760	Placement of geotextile and placement of cap. Assumes the placement of 6,000 cubic yards will take 12 days to complete.
Paint crew labor	hr	240	$75	$18,000	Assumes 10 days to paint Buildings 4202 and 4212.
Site supervisor labor	hr	420	$100	$42,000	Assumes 42 days to complete work at Decision Unit 3.
Midway lodging per diem	ea	140	$125	$17,500	Two crew per room for lodging.
Midway meals per diem	ea	280	$50	$14,000	
			Subtotal	**$222,060**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	20	$2,000	$40,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	55	$35	$1,925	Cost of paint for Buildings 4202 and 4212.
Excavation area liner costs	sf	54,000	$0.32	$17,280	Assumes the lining of an area 50 feet out from each building footprint in the Decision Unit.
Total Lead in soil testing	ea	25	$7	$175	Confirmation sampling to verify XRF field data.
			Subtotal	**$59,380**	
Disposal Costs					
Disposal of LBP	ea	8	$800	$6,400	Assumes the generation of 8 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$6,400**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$26,650	$26,650	Assumes approximately 5% of the estimated project total without contingency
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$46,650**	
			Project Subtotal	$549,714	
			15% Contingency	$82,457	
			DECISION UNIT 3 - ALTERNATIVE 4 TOTAL	**$632,171**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 34

ENGINEERING ESTIMATE - DECISION UNIT 3

ALTERNATIVE 5 - Abatement of lead on the exterior of Buildings 4203 and 4212 with excavation of soils with lead at concentrations above the PCG. Off-site disposal of the contaminated soils.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using off-site disposal	ls	1	$363,006	$363,006	Includes 11 percent of the shared project costs listed on Table 21 (costs split between the nine Decision Units).
			Subtotal	**$486,596**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$48,300**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	960	$80	$76,800	Assumes 20 days to abate the loose and flaky paint from Building 4202 and Building 4212.
Excavation crew labor	hr	280	$80	$22,400	Excavation of contaminated soils and transportation to staging area. Assumes the removal of 2,000 cubic yards of soil will take 5 days to complete.
Excavation and demolition crew labor	hr	168	$80	$13,440	Placement of excavated materials and debris in staging area. Assumes 3 days to complete.
Excavation crew labor	hr	280	$80	$22,400	Backfilling of excavation. Assumes the backfilling of the excavation with 2,000 cubic yards will take 5 days to complete.
Paint crew labor	hr	240	$75	$18,000	Assumes 10 days to paint Buildings 4202 and 4212.
Site supervisor labor	hr	430	$100	$43,000	Assumes 43 days to complete work at Decision Unit 3.
Midway lodging per diem	ea	160	$125	$20,000	Two crew per room for lodging.
Midway meals per diem	ea	320	$50	$16,000	
			Subtotal	**$232,040**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	43	$2,000	$86,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Total Lead in soil testing	ea	25	$7	$175	Confirmation sampling to verify XRF field data.
Encapsulation paint costs	gal	55	$35	$1,925	Cost of paint of Buildings 4202 and 4212.
			Subtotal	**$88,100**	
Disposal Costs					
Disposal of LBP	ea	8	$800.00	$6,400	Assumes the generation of 8 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
Disposal of soil in CONUS	ton	2,800	$50	$140,000	Assumes a 1.4 cubic yard per ton conversion. Assumed 2,000 cubic yards of soil.
			Subtotal	**$146,400**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$55,100	$55,100	Assumes approximately 5% of the estimated project total without contingency
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$75,100**	
			Project Subtotal	$1,119,869	
			15% Contingency	$167,980	
			DECISION UNIT 3 - ALTERNATIVE 5 TOTAL	**$1,287,850**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 35

ENGINEERING ESTIMATE - DECISION UNIT 4

ALTERNATIVE 2 – Abatement of lead on the exterior of Building 259, 2403, and 2404 with the excavation of soils with lead at concentrations above the PCG. On-site disposal of the contaminated soils in the consolidation unit.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using the HDPE liner cap for the consolidation unit	ls	1	$16,660	$16,660	Includes 11 percent of the shared project costs listed on Table 19 (costs split between the nine Decision Units).
			Subtotal	**$140,250.04**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$48,300**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	1,920	$80	$153,600	Assumes 40 days to abate the loose and flaky paint from Buildings 259, 2403 and 2404.
Excavation crew labor	hr	280	$80	$22,400	Excavation of contaminated soils. Assumes the removal of 2,000 cubic yards of soil will take 5 days to complete.
Excavation crew labor	hr	280	$80	$22,400	Backfilling of excavation. Assumes the backfilling of the excavation with 2,000 cubic yards will take 5 days to complete.
Paint crew labor	hr	480	$75	$36,000	Assumes 20 days to paint Buildings 259, 2403 and 2404.
Site supervisor labor	hr	600	$100	$60,000	Assumes 60 days to complete work at Decision Unit 4.
Midway lodging per diem	ea	226	$125	$28,250	Two crew per room for lodging.
Midway meals per diem	ea	451	$50	$22,550	
			Subtotal	**$345,200**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	60	$2,000	$120,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Total Lead in soil testing	ea	25	$7	$175	Confirmation sampling to verify XRF field data.
Encapsulation paint costs	gal	160	$35	$5,600	Cost of paint.
			Subtotal	**$125,775**	
Disposal Costs					
Disposal of LBP	ea	20	$800	$16,000	Assumes the generation of 20 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$16,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$38,900	$38,900	Assumes approximately 5% of the estimated project total without contingency
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$58,900**	
			Project Subtotal	$777,758	
			15% Contingency	$116,664	
			DECISION UNIT 4 - ALTERNATIVE 2 TOTAL	**$894,422**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 36

ENGINEERING ESTIMATE - DECISION UNIT 4

ALTERNATIVE 3 – Abatement of lead for the exterior of Building 259, 2403, and 2404 with excavation of soils with lead at concentrations above the PCG. On-site disposal using ex-situ stabilization methods in a consolidation unit.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using solidification at the consolidation unit	ls	1	$38,987	$38,987	Includes 11 percent of the shared project costs listed on Table 19 (costs split between the nine Decision Units).
			Subtotal	**$162,578**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$48,300**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	1920	$80	$153,600	Assumes 40 days to abate the loose and flaky paint from Buildings 259, 2403 and 2404.
Excavation crew labor	hr	280	$80	$22,400	Excavation of contaminated soils. Assumes the removal of 2,000 cubic yards of soil will take 5 days to complete.
Excavation crew labor	hr	280	$80	$22,400	Backfilling of excavation. Assumes the backfilling of the excavation with 2,000 cubic yards will take 5 days to complete.
Excavation and demolition crew labor	hr	168	$80	$13,440	Placement of excavated materials and debris in consolidation unit and implementing the solidification process. Assumes 3 days to complete.
Paint crew labor	hr	480	$75	$36,000	Assumes 20 days to paint Buildings 259, 2403 and 2404.
Site supervisor labor	hr	600	$100	$60,000	Assumes 63 days to complete work at Decision Unit 4.
Midway lodging per diem	ea	227	$125	$28,375	Two crew per room for lodging.
Midway meals per diem	ea	454	$50	$22,700	
			Subtotal	**$358,915**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	63	$2,000	$126,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	160	$35	$5,600	Cost of paint.
Total Lead in soil testing	ea	25	$7	$175	Confirmation sampling to verify XRF field data.
			Subtotal	**$131,775**	
Disposal Costs					
Disposal of LBP	ea	20	$800	$16,000	Assumes the generation of 20 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$16,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000.00	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000.00	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$41	$41	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$20,041**	
			Project Subtotal	$780,943	
			15% Contingency	$117,141	
			DECISION UNIT 4 - ALTERNATIVE 3 TOTAL	**$898,084**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 37

ENGINEERING ESTIMATE - DECISION UNIT 4

ALTERNATIVE 4 – Abatement of lead for the exterior of Building 259, 2403, and 2404 with the installation of a geomembrane and soil cap.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
			Subtotal	**$123,591**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$48,300**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	1920	$80	$153,600	Assumes 40 days to abate the loose and flaky paint from Buildings 259, 2403 and 2404.
Excavation crew labor	hr	672	$80	$53,760	Placement of geotextile and placement of cap. Assumes the placement of 6,000 cubic yards will take 12 days to complete.
Paint crew labor	hr	480	$75	$36,000	Assumes 20 days to paint Buildings 259, 2403 and 2404.
Site supervisor labor	hr	700	$100	$70,000	Assumes 70 days to complete work at Decision Unit 4.
Midway lodging per diem	ea	250	$125	$31,250	Two crew per room for lodging.
Midway meals per diem	ea	500	$50	$25,000	
			Subtotal	**$369,610**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	63	$2,000	$126,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	160	$35	$5,600	Cost of paint.
Excavation area liner costs	sf	54,000	$0.32	$17,280	Assumes the lining of an area 50 feet out from each building footprint in the Decision Unit.
Total Lead in soil testing	ea	25	$7	$175	Confirmation sampling to verify XRF field data.
			Subtotal	**$149,055**	
Disposal Costs					
Disposal of LBP	ea	20	$800	$16,000	Assumes the generation of 20 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$16,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$38,200	$38,200	Assumes approximately 5% of the estimated project total without contingency
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$58,200**	
			Project Subtotal	$808,089	
			15% Contingency	$121,213	
			DECISION UNIT 4 - ALTERNATIVE 4 TOTAL	**$929,302**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 38

ENGINEERING ESTIMATE - DECISION UNIT 4

ALTERNATIVE 5 - Abatement of lead for the exterior of Building 259, 2403, and 2404 with excavation of soils with lead at concentrations above the PCG. Off-site disposal of soil.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using off-site disposal	ls	1	$363,006	$363,006	Includes 11 percent of the shared project costs listed on Table 21 (costs split between the nine Decision Units).
			Subtotal	**$486,596**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$48,300**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	1920	$80	$153,600	Assumes 40 days to abate the loose and flaky paint from Buildings 259, 2403 and 2404.
Excavation crew labor	hr	280	$80	$22,400	Excavation of contaminated soils. Assumes the removal of 2,000 cubic yards of soil will take 5 days to complete.
Excavation crew labor	hr	280	$80	$22,400	Backfilling of excavation. Assumes the backfilling of the excavation with 2,000 cubic yards will take 5 days to complete.
Excavation and demolition crew labor	hr	168	$80	$13,440	Placement of excavated materials at staging area. Assumes 3 days to complete.
Paint crew labor	hr	480	$75	$36,000	Assumes 20 days to paint Buildings 259, 2403 and 2404.
Site supervisor labor	hr	600	$100	$60,000	Assumes 63 days to complete work at Decision Unit 4.
Midway lodging per diem	ea	227	$125	$28,375	Two crew per room for lodging.
Midway meals per diem	ea	454	$50	$22,700	
			Subtotal	**$358,915**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	63	$2,000	$126,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	160	$35	$5,600	Cost of paint.
Total Lead in soil testing	ea	25	$7	$175	Confirmation sampling to verify XRF field data.
			Subtotal	**$131,775**	
Disposal Costs					
Disposal of LBP	ea	20	$800	$16,000	Assumes the generation of 20 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
Disposal of soil in CONUS	ton	2,800	$50	$140,000	Assumes a 1.4 cubic yard per ton conversion. Assumed 2,000 cubic yards of soil.
			Subtotal	**$156,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000.00	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000.00	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$41.45	$41	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$20,041**	
			Project Subtotal	$1,244,961	
			15% Contingency	$186,744	
			DECISION UNIT 4 - ALTERNATIVE 5 TOTAL	**$1,431,705**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 39

ENGINEERING ESTIMATE - DECISION UNIT 5

ALTERNATIVE 2 – Abatement of lead for the exterior of Building 5309 and 5303 with the excavation of soils above the PCG. On-site disposal of the contaminated soils in the consolidation unit.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using the HDPE liner cap for the consolidation unit	ls	1	$16,660	$16,660	Includes 11 percent of the shared project costs listed on Table 19 (costs split between the nine Decision Units).
			Subtotal	**$140,250**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$48,300.00**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	576	$80	$46,080	Assumes 12 days to abate the loose and flaky paint from Buildings 5303 and 5309.
Excavation crew labor	hr	112	$80	$8,960	Excavation of contaminated soils. Assumes the removal of 1,000 cubic yards of soil will take 2 days to complete.
Excavation crew labor	hr	112	$80	$8,960	Backfilling of excavation. Assumes the backfilling of the excavation with 1,000 cubic yards will take 2 days to complete.
Paint crew labor	hr	120	$75	$9,000	Assumes 5 days to paint.
Site supervisor labor	hr	250	$100	$25,000	Assumes 21 days to complete work at Decision Unit 5.
Midway lodging per diem	ea	75	$125	$9,375	Two crew per room for lodging.
Midway meals per diem	ea	150	$50	$7,500	
			Subtotal	**$114,875.00**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	21	$2,000	$42,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Total Lead in soil testing	ea	25	$7	$175	Confirmation sampling to verify XRF field data.
Encapsulation paint costs	gal	50	$35	$1,750	Cost of paint.
			Subtotal	**$43,925**	
Disposal Costs					
Disposal of LBP	ea	5	$800	$4,000	Assumes the generation of 5 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$4,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$22,250	$22,250	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$42,250**	
			Project Subtotal	$436,933	
			15% Contingency	$65,540	
			DECISION UNIT 5 - ALTERNATIVE 2 TOTAL	**$502,473**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 40

ENGINEERING ESTIMATE - DECISION UNIT 5

ALTERNATIVE 3 – Abatement of lead for the exterior of Building 5309 and 5303 with excavation of soils above the PCG. On-site disposal using ex-situ stabilization methods in a consolidation unit.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using solidification at the consolidation unit	ls	1	$38,987	$38,987	Includes 11 percent of the shared project costs listed on Table 20 (costs split between the nine Decision Units).
			Subtotal	**$162,578**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$48,300**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	576	$80	$46,080	Assumes 12 days to abate the loose and flaky paint from Buildings 5303 and 5309.
Excavation crew labor	hr	112	$80	$8,960	Excavation of contaminated soils. Assumes the removal of 1,000 cubic yards of soil will take 2 days to complete.
Excavation crew labor	hr	112	$80	$8,960	Backfilling of excavation. Assumes the backfilling of the excavation with 1,000 cubic yards will take 4 days to complete.
Excavation and demolition crew labor	hr	168	$80	$13,440	Placement of excavated materials and debris in consolidation unit and implementing the solidification process. Assumes 3 days to complete.
Paint crew labor	hr	120	$75	$9,000	Assumes 5 days to paint.
Site supervisor labor	hr	250	$100	$25,000	Assumes 24 days to complete work at Decision Unit 5.
Midway lodging per diem	ea	77	$125	$9,625	Two crew per room for lodging.
Midway meals per diem	ea	154	$50	$7,700	
			Subtotal	**$128,765**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	24	$2,000	$48,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	50	$35	$1,750	Cost of paint.
Total Lead in soil testing	ea	25	$7	$175	Confirmation sampling to verify XRF field data.
			Subtotal	**$49,925**	
Disposal Costs					
Disposal of LBP	ea	5	$800	$4,000	Assumes the generation of 5 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$4,000.00**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333.33**	
Reporting and Project Management					
Project management and administration	ls	1	$23,100	$23,100	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$43,100**	
			Project Subtotal	$480,001	
			15% Contingency	$72,000	
			DECISION UNIT 5 - ALTERNATIVE 3 TOTAL	**$552,001**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 41

ENGINEERING ESTIMATE - DECISION UNIT 5

ALTERNATIVE 4 – Abatement of lead for the exterior of Building 5309 and 5303 with the installation of a geomembrane and soil cap.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
			Subtotal	**$123,591**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$48,300**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	576	$80	$46,080	Assumes 12 days to abate the loose and flaky paint from Buildings 5303 and 5309.
Excavation crew labor	hr	224	$80	$17,920	Placement of geotextile and placement of cap. Assumes the placement of 3,000 cubic yards will take 4 days to complete.
Paint crew labor	hr	120	$75	$9,000	Assumes 5 days to paint.
Site supervisor labor	hr	210	$100	$21,000	Assumes 21 days to complete work at Decision Unit 5.
Midway lodging per diem	ea	75	$125	$9,375	Two crew per room for lodging.
Midway meals per diem	ea	150	$50	$7,500	
			Subtotal	**$110,875**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	21	$2,000	$42,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	50	$35	$1,750	Cost of paint.
Excavation area liner costs	sf	30,000	$0.32	$9,600	Assumes the lining of an area 50 feet out from each building footprint in the Decision Unit.
Total Lead in soil testing	ea	25	$7	$175	Confirmation sampling to verify XRF field data.
			Subtotal	**$53,525**	
Disposal Costs					
Disposal of LBP	ea	5	$800	$4,000	Assumes the generation of 5 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$4,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$22,050	$22,050	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$42,050**	
			Project Subtotal	$425,674	
			15% Contingency	$63,851	
			DECISION UNIT 5 - ALTERNATIVE 4 TOTAL	**$489,525**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 42

ENGINEERING ESTIMATE - DECISION UNIT 5

ALTERNATIVE 5 - Abatement of lead for the exterior of Building 5309 and 5303 with excavation of soils above the PCG. Off-site disposal of soil.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using off-site disposal	ls	1	$363,006	$363,006	Includes 11 percent of the shared project costs listed on Table 21 (costs split between the nine Decision Units).
			Subtotal	**$486,596**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$48,300**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	576	$80	$46,080	Assumes 12 days to abate the loose and flaky paint from Buildings 5303 and 5309.
Excavation crew labor	hr	112	$80	$8,960	Excavation of contaminated soils. Assumes the removal of 1,000 cubic yards of soil will take 2 days to complete.
Excavation crew labor	hr	112	$80	$8,960	Backfilling of excavation. Assumes the backfilling of the excavation with 1,000 cubic yards will take 4 days to complete.
Excavation and demolition crew labor	hr	168	$80	$13,440	Placement of excavated materials in staging area. Assumes 3 days to complete.
Paint crew labor	hr	120	$75	$9,000	Assumes 5 days to paint.
Site supervisor labor	hr	250	$100	$25,000	Assumes 24 days to complete work at Decision Unit 5.
Midway lodging per diem	ea	77	$125	$9,625	Two crew per room for lodging.
Midway meals per diem	ea	154	$50	$7,700	
			Subtotal	**$128,765**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	24	$2,000	$48,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	50	$35	$1,750	Cost of paint.
Total Lead in soil testing	ea	25	$7	$175	Confirmation sampling to verify XRF field data.
			Subtotal	**$49,925**	
Disposal Costs					
Disposal of LBP	ea	5	$800	$4,000	Assumes the generation of 5 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
Disposal of soil in CONUS	ton	1,400	$50	$70,000	Assumes a 1.4 cubic yard per ton conversion. Assumed 1,000 cubic yards of soil.
			Subtotal	**$74,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$43,700	$43,700	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$63,700**	
			Project Subtotal	$894,619	
			15% Contingency	$134,193	
			DECISION UNIT 5 - ALTERNATIVE 5 TOTAL	**$1,028,812**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 43

ENGINEERING ESTIMATE - DECISION UNIT 6

ALTERNATIVE 2 – Abatement of lead for the exterior of the buildings with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the contaminated soils in the consolidation unit.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using the HDPE liner cap for the consolidation unit	ls	1	$16,660	$16,660	Includes 11 percent of the shared project costs listed on Table 20 (costs split between the nine Decision Units).
			Subtotal	**$140,250**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - painting crew	ea	3	$3,450	$10,350	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$58,650**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	3360	$80	$268,800	Assumes 70 days to abate the loose and flaky lead based paint from exterior of buildings.
Excavation crew labor	hr	336	$80	$26,880	Excavation of contaminated soils. Assumes the removal of 4,500 cubic yards of soil will take 6 days to complete.
Excavation crew labor	hr	840	$80	$67,200	Placement of geotextile and backfilling of excavation. Assumes the backfilling of the excavation with 13,500 cubic yards will take 15 days to complete.
Paint crew labor	hr	1080	$75	$81,000	Assumes 45 days to paint all buildings.
Site supervisor labor	hr	1250	$100	$125,000	Assumes 125 days to complete work at Decision Unit 6.
Midway lodging per diem	ea	410	$125	$51,250	Assumes two crew per room for lodging.
Midway meals per diem	ea	820	$50	$41,000	
			Subtotal	**$661,130**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	80	$2,000	$160,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	350	$35	$12,250	Cost of paint for Buildings with EcoBond by MT2.
Excavation area liner costs	sf	122,000	$0.32	$39,040	Assumes the lining of an area 50 feet out from each building footprint in the Decision Unit.
Total Lead in soil testing	ea	100	$7	$700	Confirmation sampling to verify XRF field data.
			Subtotal	**$211,990**	
Disposal Costs					
Disposal of LBP	ea	50	$800	$40,000	Assumes the generation of 50 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$40,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$60,000	$60,000	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$80,000**	
			Project Subtotal	$1,235,353	
			15% Contingency	$185,303	
			DECISION UNIT 6 - ALTERNATIVE 2 TOTAL	**$1,420,656**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 44

ENGINEERING ESTIMATE - DECISION UNIT 6

ALTERNATIVE 3 – Abatement of lead on the exterior of the buildings with limited excavation of soils and the installation of a geomembrane and a soil cap. On-site disposal using ex-situ stabilization methods in a consolidation unit.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using solidification at the consolidation unit	ls	1	$38,987	$38,987	Includes 11 percent of the shared project costs listed on Table 20 (costs split between the nine Decision Units).
			Subtotal	**$162,577.80**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - painting crew	ea	3	$3,450	$10,350	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$58,650**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	3360	$80.00	$268,800	Assumes 70 days to abate the loose and flaky lead based paint from exterior of buildings.
Excavation crew labor	hr	336	$80	$26,880	Excavation of contaminated soils. Assumes the removal of 4,500 cubic yards of soil will take 6 days to complete.
Excavation crew labor	hr	840	$80	$67,200	Placement of geotextile and backfilling of excavation. Assumes the backfilling of the excavation with 13,500 cubic yards will take 15 days to complete.
Excavation and demolition crew labor	hr	280	$80	$22,400	Placement of excavated materials and debris in consolidation unit and implementing the solidification process. Assumes 5 days to complete.
Paint crew labor	hr	1080	$75	$81,000	Assumes 45 days to paint all buildings.
Site supervisor labor	hr	1250	$100	$125,000	Assumes 125 days to complete work at Decision Unit 6.
Midway lodging per diem	ea	410	$125	$51,250	Assumes two crew per room for lodging.
Midway meals per diem	ea	820	$50	$41,000	
			Subtotal	**$683,530**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	80	$2,000	$160,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	350	$35	$12,250	Cost of paint for Building 643 with EcoBond by MT2.
Excavation area liner costs	sf	122,000	$0.32	$39,040	Assumes the lining of an area 50 feet out from each building footprint in the Decision Unit.
Total Lead in soil testing	ea	100	$7	$700	Confirmation sampling to verify XRF field data.
			Subtotal	**$211,990**	
Disposal Costs					
Disposal of LBP	ea	50	$800	$40,000	Assumes the generation of 50 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$40,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333.33**	
Reporting and Project Management					
Project management and administration	ls	1	$60,000	$60,000	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$80,000**	
			Project Subtotal	$1,280,081	
			15% Contingency	$192,012	
			DECISION UNIT 6 - ALTERNATIVE 3 TOTAL	**$1,472,093**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 45

ENGINEERING ESTIMATE - DECISION UNIT 6

ALTERNATIVE 4 – Abatement of lead for the exterior of the buildings and the installation of a geomembrane and soil cap.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
			Subtotal	**$123,591**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - painting crew	ea	3	$3,450	$10,350	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$58,650**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	3360	$80	$268,800	Assumes 70 days to abate the loose and flaky lead based paint from exterior of buildings.
Excavation crew labor	hr	840	$80	$67,200	Placement of geotextile and backfilling of excavation. Assumes the backfilling of the excavation with 13,500 cubic yards will take 15 days to complete.
Paint crew labor	hr	1080	$75	$81,000	Assumes 45 days to paint all buildings.
Site supervisor labor	hr	1200	$100	$120,000	Assumes 120 days to complete work at Decision Unit 6.
Midway lodging per diem	ea	389	$125	$48,625	Assumes two crew per room for lodging.
Midway meals per diem	ea	775	$50	$38,750	
			Subtotal	**$624,375**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	80	$2,000	$160,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	350	$35	$12,250	Cost of paint for Building 643.
Excavation area liner costs	sf	122,000	$0.32	$39,040	Assumes the lining of an area 50 feet out from each building footprint in the Decision Unit.
Total Lead in soil testing	ea	100	$7	$700	Confirmation sampling to verify XRF field data.
			Subtotal	**$211,990**	
Disposal Costs					
Disposal of LBP	ea	50	$800	$40,000	Assumes the generation of 50 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$40,000.00**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$50,000	$50,000	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$70,000**	
			Project Subtotal	$1,171,939	
			15% Contingency	$175,791	
			DECISION UNIT 6 - ALTERNATIVE 4 TOTAL	**$1,347,730**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 46

ENGINEERING ESTIMATE - DECISION UNIT 6

ALTERNATIVE 5 - Abatement of lead on the exterior of the buildings with limited excavation of soils and the installation of a geomembrane and a soil cap. Off-site disposal of soil.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using off-site disposal	ls	1	$363,006	$363,006	Includes 11 percent of the shared project costs listed on Table 21 (costs split between the nine Decision Units).
			Subtotal	**$486,596**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - painting crew	ea	3	$3,450	$10,350	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$58,650**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	3,360	$80	$268,800	Assumes 70 days to abate the loose and flaky lead based paint from exterior of buildings.
Excavation crew labor	hr	336	$80	$26,880	Excavation of contaminated soils. Assumes the removal of 4,500 cubic yards of soil will take 6 days to complete.
Excavation crew labor	hr	840	$80	$67,200	Placement of geotextile and backfilling of excavation. Assumes the backfilling of the excavation with 13,500 cubic yards will take 15 days to complete.
Excavation and demolition crew labor	hr	392	$80	$31,360	Placement of excavated materials in staging area. Assumes 7 days to complete.
Paint crew labor	hr	1,080	$75	$81,000	Assumes 45 days to paint all buildings.
Site supervisor labor	hr	1,250	$100	$125,000	Assumes 125 days to complete work at Decision Unit 6.
Midway lodging per diem	ea	410	$125	$51,250	Assumes two crew per room for lodging.
Midway meals per diem	ea	820	$50	$41,000	
			Subtotal	**$692,490**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	80	$2,000	$160,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	350	$35	$12,250	Cost of paint for Buildings with EcoBond by MT2.
Excavation area liner costs	sf	122,000	$0.32	$39,040	Assumes the lining of an area 50 feet out from each building footprint in the Decision Unit.
Total Lead in soil testing	ea	100	$7	$700	Confirmation sampling to verify XRF field data.
			Subtotal	**$211,990**	
Disposal Costs					
Disposal of LBP	ea	50	$800	$40,000	Assumes the generation of 50 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
Disposal of soil in CONUS	ton	6,300	$50	$315,000	Assumes a 1.4 cubic yard per ton conversion. Assumed 4,500 cubic yards of soil.
			Subtotal	**$355,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$95,000	$95,000	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$115,000**	
			Project Subtotal	$1,963,059	
			15% Contingency	$294,459	
			DECISION UNIT 6 - ALTERNATIVE 5 TOTAL	**$2,257,518**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 47

ENGINEERING ESTIMATE - DECISION UNIT 6

ALTERNATIVE 6 - Abatement of lead on the exterior of the buildings with limited excavation of soils and the installation of a geomembrane and a soil cap. On-site disposal of the soils using ex-site soil stabilization methods in a containment cell constructed near the Decision Unit.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
			Subtotal	**$123,591**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - painting crew	ea	3	$3,450	$10,350	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$58,650**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	3,360	$80	$268,800	Assumes 70 days to abate the loose and flaky lead based paint from exterior of buildings.
Excavation crew labor	hr	336	$80	$26,880	Excavation of contaminated soils. Assumes the removal of 4,500 cubic yards of soil will take 6 days to complete.
Excavation and demolition crew labor	hr	1120	$80	$89,600	Excavation of containment cell near Decision Unit. Excvaation will be ~13,500 cubic yards in size. Assumes the excavation and backfilling of the contaminated soil excavation will take 20 days to complete. Backfilling of excavation left by contaminated soil will be completed at the same time.
Excavation and demolition crew labor	hr	560	$80	$44,800	Placement of contaminated soil in consolidation using ex-situ stabilization and capping with clean soil. Assumes the backfilling of the excavation with 4,500 cubic yards of contaminated soil and clean soil will take 10 days to complete.
Paint crew labor	hr	1,080	$75	$81,000	Assumes 45 days to paint all buildings.
Site supervisor labor	hr	1,350	$100	$135,000	Assumes 135 days to complete work at Decision Unit 6.
Midway lodging per diem	ea	420	$125	$52,500	Assumes two crew per room for lodging.
Midway meals per diem	ea	840	$50	$42,000	
			Subtotal	**$740,580**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	80	$2,000	$160,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	350	$35	$12,250	Cost of paint for Buildings with EcoBond by MT2.
Excavation area liner costs	sf	122,000	$0.32	$39,040	Assumes the lining of an area 50 feet out from each building footprint in the Decision Unit.
Total Lead in soil testing	ea	100	$7	$700	Confirmation sampling to verify XRF field data.
			Subtotal	**$211,990**	
Disposal Costs					
Disposal of LBP	ea	50	$800	$40,000	Assumes the generation of 50 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$40,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$95,000	$95,000	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$115,000**	
			Project Subtotal	$1,333,144	
			15% Contingency	$199,972	
			DECISION UNIT 6 - ALTERNATIVE 6 TOTAL	**$1,533,115**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
CONUS = Continental United States
gal = gallon
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 48

ENGINEERING ESTIMATE - DECISION UNIT 7

ALTERNATIVE 2 – Abatement of lead for the exterior of the buildings and the excavation of soils above the PCG. On-site disposal of the contaminated soils in the consolidation unit.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using the HDPE liner cap for the consolidation unit	ls	1	$16,660	$16,660	Includes 11 percent of the shared project costs listed on Table 20 (costs split between the nine Decision Units).
			Subtotal	**$140,250**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$48,300**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	960	$80	$76,800	Assumes 20 days to abate the loose and flaky paint.
Excavation crew labor	hr	336	$80	$26,880	Excavation of contaminated soils. Assumes the removal of 3,200 cubic yards of soil will take 6 days to complete.
Excavation crew labor	hr	336	$80	$26,880	Backfilling of excavation. Assumes the backfilling of the excavation with 3,200 cubic yards will take 6 days to complete.
Paint crew labor	hr	528	$75	$39,600	Assumes 22 days to paint.
Site supervisor labor	hr	530	$100	$53,000	Assumes 53 days to complete work at Decision Unit 7.
Midway lodging per diem	ea	162	$125	$20,250	Two crew per room for lodging.
Midway meals per diem	ea	323	$50	$16,150	
			Subtotal	**$259,560**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	32	$2,000	$64,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Total Lead in soil testing	ea	50	$7	$350	Confirmation sampling to verify XRF field data.
Encapsulation paint costs	gal	100	$35	$3,500	Cost of paint.
			Subtotal	**$67,850**	
Disposal Costs					
Disposal of LBP	ea	20	$800	$16,000	Assumes the generation of 20 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$16,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$30,650	$30,650	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$50,650**	
			Project Subtotal	$625,943	
			15% Contingency	$93,892	
			DECISION UNIT 7 - ALTERNATIVE 2 TOTAL	**$719,835**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 49

ENGINEERING ESTIMATE - DECISION UNIT 7

ALTERNATIVE 3 – Abatement of lead for the exterior of the buildings and excavation of soils above the PCG. On-site disposal using ex-situ stabilization methods in a consolidation unit.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using solidification at the consolidation unit	ls	1	$38,987	$38,987	Includes 11 percent of the shared project costs listed on Table 19 (costs split between the nine Decision Units).
			Subtotal	**$162,578**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$48,300**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	960	$80	$76,800	Assumes 20 days to abate the loose and flaky paint.
Excavation crew labor	hr	336	$80	$26,880	Excavation of contaminated soils. Assumes the removal of 3,200 cubic yards of soil will take 6 days to complete.
Excavation crew labor	hr	336	$80	$26,880	Backfilling of excavation. Assumes the backfilling of the excavation with 3,200 cubic yards will take 6 days to complete.
Excavation and demolition crew labor	hr	280	$80	$22,400	Placement of excavated materials and debris in consolidation unit and implementing the solidification process. Assumes 5 days to complete.
Paint crew labor	hr	528	$75	$39,600	Assumes 22 days to paint.
Site supervisor labor	hr	580	$100	$58,000	Assumes 58 days to complete work at Decision Unit 7.
Midway lodging per diem	ea	164	$125	$20,500	Two crew per room for lodging.
Midway meals per diem	ea	328	$50	$16,400	
			Subtotal	**$287,460**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	37	$2,000	$74,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	100	$35	$3,500	Cost of paint.
Total Lead in soil testing	ea	50	$7	$350	Confirmation sampling to verify XRF field data.
			Subtotal	**$77,850**	
Disposal Costs					
Disposal of LBP	ea	20	$800	$16,000	Assumes the generation of 20 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$16,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000.00	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000.00	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$27,000	$27,000	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$47,000**	
			Project Subtotal	$682,521	
			15% Contingency	$102,378	
			DECISION UNIT 7 - ALTERNATIVE 3 TOTAL	**$784,899**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 50

ENGINEERING ESTIMATE - DECISION UNIT 7

ALTERNATIVE 4 – Abatement of lead for the exterior of the buildings with the installation of a geomembrane and soil cap.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
			Subtotal	**$123,591**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$48,300**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	960	$80	$76,800	Assumes 20 days to abate the loose and flaky paint.
Excavation crew labor	hr	896	$80	$71,680	Placement of geotextile and placement of cap. Assumes the placement of 9,600 cubic yards will take 16 days to complete.
Paint crew labor	hr	528	$75	$39,600	Assumes 22 days to paint.
Site supervisor labor	hr	620	$100	$62,000	Assumes 62 days to complete work at Decision Unit 7.
Midway lodging per diem	ea	180	$125	$22,500	Two crew per room for lodging.
Midway meals per diem	ea	360	$50	$18,000	
			Subtotal	**$290,580**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	37	$2,000	$74,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	100	$35	$3,500	Cost of paint.
Excavation area liner costs	sf	87,000	$0.32	$27,840	Assumes the lining of an area 50 feet out from each building footprint in the Decision Unit.
Total Lead in soil testing	ea	50	$7	$350	Confirmation sampling to verify XRF field data.
			Subtotal	**$105,690**	
Disposal Costs					
Disposal of LBP	ea	20	$800	$16,000	Assumes the generation of 20 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$16,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333.33**	
Reporting and Project Management					
Project management and administration	ls	1	$30,300	$30,300	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$50,300**	
			Project Subtotal	$677,794	
			15% Contingency	$101,669	
			DECISION UNIT 7 - ALTERNATIVE 4 TOTAL	**$779,463**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 51

ENGINEERING ESTIMATE - DECISION UNIT 7

ALTERNATIVE 5 - Abatement of lead for the exterior of the buildings and excavation of soils above the PCG. Off-site disposal of soils.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using off-site disposal	ls	1	$363,006	$363,006	Includes 11 percent of the shared project costs listed on Table 21 (costs split between the nine Decision Units).
			Subtotal	**$486,596**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$48,300**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	960	$80	$76,800	Assumes 20 days to abate the loose and flaky paint.
Excavation crew labor	hr	336	$80	$26,880	Excavation of contaminated soils. Assumes the removal of 3,200 cubic yards of soil will take 6 days to complete.
Excavation crew labor	hr	336	$80	$26,880	Backfilling of excavation. Assumes the backfilling of the excavation with 3,200 cubic yards will take 6 days to complete.
Excavation and demolition crew labor	hr	336	$80	$26,880	Placement of excavated materials in staging area. Assumes 6 days to complete.
Paint crew labor	hr	528	$75	$39,600	Assumes 22 days to paint.
Site supervisor labor	hr	530	$100	$53,000	Assumes 53 days to complete work at Decision Unit 7.
Midway lodging per diem	ea	162	$125	$20,250	Two crew per room for lodging.
Midway meals per diem	ea	323	$50	$16,150	
			Subtotal	**$286,440**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	32	$2,000	$64,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Total Lead in soil testing	ea	50	$7	$350	Confirmation sampling to verify XRF field data.
Encapsulation paint costs	gal	100	$35	$3,500	Cost of paint.
			Subtotal	**$67,850**	
Disposal Costs					
Disposal of LBP	ea	20	$800	$16,000	Assumes the generation of 20 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
Disposal of soil in CONUS	ton	4,480	$50	$224,000	Assumes a 1.4 cubic yard per ton conversion. Assumed 3,200 cubic yards of soil.
			Subtotal	**$240,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$60,000	$60,000	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$80,000**	
			Project Subtotal	$1,252,519	
			15% Contingency	$187,878	
			DECISION UNIT 7 - ALTERNATIVE 5 TOTAL	**$1,440,397**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 52

ENGINEERING ESTIMATE - DECISION UNIT 8

ALTERNATIVE 2 – Decommissioning of each AST by removal with excavation of soils from the Decision Unit. On-site disposal of the contaminated soils in a lined consolidation unit.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using the HDPE liner cap for the consolidation unit	ls	1	$16,660	$16,660	Includes 11 percent of the shared project costs listed on Table 19 (costs split between the nine Decision Units).
			Subtotal	**$140,250.04**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$27,600**	
Field Activities - Project Crew Costs					
Excavation and demolition crew labor	hr	1680	$80	$134,400	Demolition of ASTs and staging of scrap metal. Assumes 30 days to complete the demolition and hauling of debris.
Excavation and demolition crew labor	hr	56	$80	$4,480	Excavation of contaminated soils. Assumes the removal of 800 cubic yards of soil will take 1 day to complete.
Excavation and demolition crew labor	hr	56	$80	$4,480	Backfilling of excavation. Assumes the backfilling of the excavation with 800 cubic yards will take 1 day to complete.
Site supervisor labor	hr	300	$100	$30,000	Assumes 30 days to complete work at Decision Unit 1.
Midway lodging per diem	ea	120	$125	$15,000	Assumes 30 days to complete work for 8 workers. Two crew per room for lodging.
Midway meals per diem	ea	240	$50	$12,000	Assumes 30 days to complete work for 8 workers.
			Subtotal	**$200,360**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	30	$2,000	$60,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Total Lead in soil testing	ea	25	$7	$175	Confirmation sampling to verify XRF field data.
			Subtotal	**$60,175**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333.33**	
Reporting and Project Management					
Project management and administration	ls	1	$27,000	$27,000	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$47,000**	
			Project Subtotal	$518,718	
			15% Contingency	$77,808	
			DECISION UNIT 8 - ALTERNATIVE 2 TOTAL	**$596,526**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 53

ENGINEERING ESTIMATE - DECISION UNIT 8

ALTERNATIVE 3 – Decommissioning of each AST by removal with excavation of soils from the Decision Unit. On-site disposal using ex-situ stabilization methods in a consolidation unit.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using solidification at the consolidation unit	ls	1	$38,987	$38,987	Includes 11 percent of the shared project costs listed on Table 20 (costs split between the nine Decision Units).
			Subtotal	**$162,578**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$27,600**	
Field Activities - Project Crew Costs					
Excavation and demolition crew labor	hr	1680	$80	$134,400	Demolition of ASTs and staging of scrap metal. Assumes 30 days to complete the demolition and hauling of debris.
Excavation and demolition crew labor	hr	56	$80	$4,480	Excavation of contaminated soils. Assumes the removal of 800 cubic yards of soil will take 1 day to complete.
Excavation and demolition crew labor	hr	112	$80	$8,960	Placement of excavated materials and debris in consolidation unit and implementing the solidification process. Assumes 2 days to complete.
Excavation and demolition crew labor	hr	56	$80	$4,480	Backfilling of excavation. Assumes the backfilling of the excavation with 800 cubic yards will take 1 day to complete.
Site supervisor labor	hr	300	$100	$30,000	Assumes 30 days to complete work at Decision Unit 1.
Midway lodging per diem	ea	120	$125	$15,000	Assumes 30 days to complete work for 8 workers. Two crew per room for lodging.
Midway meals per diem	ea	240	$50	$12,000	Assumes 30 days to complete work for 8 workers.
			Subtotal	**$209,320**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	30	$2,000	$60,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Total Lead in soil testing	ea	25	$7	$175	Confirmation sampling to verify XRF field data.
			Subtotal	**$60,175**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333.33**	
Reporting and Project Management					
Project management and administration	ls	1	$28,500	$28,500	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$48,500**	
			Project Subtotal	$551,506	
			15% Contingency	$82,726	
			DECISION UNIT 8 - ALTERNATIVE 3 TOTAL	**$634,232**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 54

ENGINEERING ESTIMATE - DECISION UNIT 8

ALTERNATIVE 4 – Decommissioning of each AST by removal with placement of a geomembrane and capping of the soils.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
			Subtotal	**$123,591**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$27,600**	
Field Activities - Project Crew Costs					
Excavation and demolition crew labor	hr	1680	$80	$134,400	Demolition of ASTs and staging of scrap metal. Assumes 30 days to complete the demolition and hauling of debris.
Excavation and demolition crew labor	hr	224	$80	$17,920	Placement of geomembrane and placement of cap. Assumes the placement of the cap using 2,400 cubic yards will take 4 days to complete.
Site supervisor labor	hr	300	$100	$30,000	Assumes 32 days to complete work at Decision Unit 1.
Midway lodging per diem	ea	128	$125	$16,000	Assumes 32 days to complete work for 8 workers. Two crew per room for lodging.
Midway meals per diem	ea	256	$50	$12,800	Assumes 32 days to complete work for 8 workers.
			Subtotal	**$211,120**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	30	$2,000.00	$60,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Excavation area liner costs	sf	30,000	$0.32	$9,600	Assumes the lining of the Decision Unit.
Total Lead in soil testing	ea	25	$7.00	$175	Confirmation sampling to verify XRF field data.
			Subtotal	**$69,775**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$26,500	$26,500	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$46,500**	
			Project Subtotal	$521,919	
			15% Contingency	$78,288	
			DECISION UNIT 8 - ALTERNATIVE 4 TOTAL	**$600,207**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 55

ENGINEERING ESTIMATE - DECISION UNIT 8

ALTERNATIVE 5 - Decommissioning of each AST by removal with excavation of soils from the Decision Unit. Off-site disposal of soils.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using off-site disposal	ls	1	$363,006	$363,006	Includes 11 percent of the shared project costs listed on Table 21 (costs split between the nine Decision Units).
			Subtotal	**$486,596**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$27,600**	
Field Activities - Project Crew Costs					
Excavation and demolition crew labor	hr	1680	$80	$134,400	Demolition of ASTs and staging of scrap metal. Assumes 30 days to complete the demolition and hauling of debris.
Excavation and demolition crew labor	hr	56	$80	$4,480	Excavation of contaminated soils. Assumes the removal of 800 cubic yards of soil will take 1 day to complete.
Excavation and demolition crew labor	hr	112	$80	$8,960	Placement of excavated materials and debris at staging area. Assumes 2 days to complete.
Excavation and demolition crew labor	hr	56	$80	$4,480	Backfilling of excavation. Assumes the backfilling of the excavation with 800 cubic yards will take 1 day to complete.
Site supervisor labor	hr	300	$100	$30,000	Assumes 30 days to complete work at Decision Unit 1.
Midway lodging per diem	ea	120	$125	$15,000	Assumes 30 days to complete work for 8 workers. Two crew per room for lodging.
Midway meals per diem	ea	240	$50	$12,000	Assumes 30 days to complete work for 8 workers.
			Subtotal	**$209,320**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	30	$2,000	$60,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Total Lead in soil testing	ea	25	$7	$175	Confirmation sampling to verify XRF field data.
			Subtotal	**$60,175**	
Disposal Costs					
Disposal of soil in CONUS	ton	1,120	$50	$56,000	Assumes a 1.4 cubic yard per ton conversion. Assumed 800 cubic yards of soil.
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$43,750	$43,750	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$63,750**	
			Project Subtotal	$890,774	
			15% Contingency	$133,616	
			DECISION UNIT 8 - ALTERNATIVE 5 TOTAL	**$1,024,391**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 56

ENGINEERING ESTIMATE - DECISION UNIT 9

ALTERNATIVE 2 – Abatement of lead for the exterior of the structures with limited excavation and the installation of a geomembrane and a soil cap. On-site disposal of the contaminated soils in the consolidation unit.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using the HDPE liner cap for the consolidation unit	ls	1	$16,660	$16,660	Includes 11 percent of the shared project costs listed on Table 19 (costs split between the nine Decision Units).
			Subtotal	**$140,250**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - painting crew	ea	3	$3,450	$10,350	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$58,650**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	4,800	$80	$384,000	Assumes 100 days to abate the loose and flaky lead based paint from exterior of buildings.
Excavation crew labor	hr	840	$80	$67,200	Excavation of contaminated soils. Assumes the removal of 6,000 cubic yards of soil will take 15 days to complete.
Excavation crew labor	hr	2,240	$80	$179,200	Placement of geotextile and backfilling of excavation. Assumes the backfilling of the excavation with 18,000 cubic yards will take 40 days to complete.
Paint crew labor	hr	600	$75	$45,000	Assumes 25 days to paint all buildings.
Site supervisor labor	hr	1,100	$100	$110,000	Assumes 110 days to complete work at Decision Unit 9.
Midway lodging per diem	ea	545	$125	$68,125	Assumes two crew per room for lodging.
Midway meals per diem	ea	1,090	$50	$54,500	
			Subtotal	**$908,025**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	100	$2,000	$200,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	200	$35	$7,000	Cost of paint for Buildings with EcoBond by MT2.
Excavation area liner costs	sf	175,000	$0.32	$56,000	Assumes the lining of an area 50 feet out from each building footprint in the Decision Unit.
Total Lead in soil testing	ea	250	$7	$1,750	Confirmation sampling to verify XRF field data.
			Subtotal	**$264,750**	
Disposal Costs					
Disposal of LBP	ea	75	$800	$60,000	Assumes the generation of 75 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$60,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000.00	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000.00	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333**	
Reporting and Project Management					
Project management and administration	ls	1	$75,000.00	$75,000	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000.00	$20,000	
			Subtotal	**$95,000**	
			Project Subtotal	$1,570,008	
			15% Contingency	$235,501	
			DECISION UNIT 9 - ALTERNATIVE 2 TOTAL	**$1,805,510**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 57

ENGINEERING ESTIMATE - DECISION UNIT 9

ALTERNATIVE 3 – Abatement of lead for the exterior of the structures with limited excavation of soils and the installation of a geomembrane and a soil cap. On-site disposal using ex-situ stabilization methods in a consolidation unit.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using solidification at the consolidation unit	ls	1	$38,987	$38,987	Includes 11 percent of the shared project costs listed on Table 20 (costs split between the nine Decision Units).
			Subtotal	**$162,578**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - painting crew	ea	3	$3,450	$10,350	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$58,650**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	4,800	$80	$384,000	Assumes 100 days to abate the loose and flaky lead based paint from exterior of buildings.
Excavation crew labor	hr	840	$80	$67,200	Excavation of contaminated soils. Assumes the removal of 6,000 cubic yards of soil will take 15 days to complete.
Excavation crew labor	hr	2,240	$80	$179,200	Placement of geotextile and backfilling of excavation. Assumes the backfilling of the excavation with 18,000 cubic yards will take 40 days to complete.
Excavation crew labor	hr	392	$80	$31,360	Placement of excavated materials and debris in consolidation unit and implementing the solidification process. Assumes 7 days to complete.
Paint crew labor	hr	600	$75	$45,000	Assumes 25 days to paint all buildings.
Site supervisor labor	hr	1,100	$100	$110,000	Assumes 110 days to complete work at Decision Unit 9.
Midway lodging per diem	ea	545	$125	$68,125	Assumes two crew per room for lodging.
Midway meals per diem	ea	1,090	$50	$54,500	
			Subtotal	**$939,385**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	100	$2,000	$200,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	200	$35	$7,000	Cost of paint for Buildings with EcoBond by MT2.
Excavation area liner costs	sf	175,000	$0.32	$56,000	Assumes the lining of an area 50 feet out from each building footprint in the Decision Unit.
Total Lead in soil testing	ea	250	$7	$1,750	Confirmation sampling to verify XRF field data.
			Subtotal	**$264,750.00**	
Disposal Costs					
Disposal of LBP	ea	75	$800	$60,000	Assumes the generation of 75 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$60,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333.33**	
Reporting and Project Management					
Project management and administration	ls	1	$75,000	$75,000	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$95,000**	
			Project Subtotal	$1,623,696	
			15% Contingency	$243,554	
			DECISION UNIT 9 - ALTERNATIVE 3 TOTAL	**$1,867,251**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 58

ENGINEERING ESTIMATE - DECISION UNIT 9

ALTERNATIVE 4 – Abatement of lead for the exterior of the structures and the installation of a geomembrane and soil cap.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
			Subtotal	**$123,591**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - painting crew	ea	3	$3,450	$10,350	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$58,650.00**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	4,800	$80	$384,000	Assumes 100 days to abate the loose and flaky lead based paint from exterior of buildings.
Excavation crew labor	hr	2,240	$80	$179,200	Placement of geotextile and backfilling of excavation. Assumes the backfilling of the excavation with 18,000 cubic yards will take 40 days to complete.
Paint crew labor	hr	600	$75	$45,000	Assumes 25 days to paint all buildings.
Site supervisor labor	hr	1,100	$100	$110,000	Assumes 110 days to complete work at Decision Unit 9.
Midway lodging per diem	ea	545	$125	$68,125	Assumes two crew per room for lodging.
Midway meals per diem	ea	1,090	$50	$54,500	
			Subtotal	**$840,825.00**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	70	$2,000	$140,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	200	$35	$7,000	Cost of paint for Building 643.
Excavation area liner costs	sf	175,000	$0.32	$56,000	Assumes the lining of an area 50 feet out from each building footprint in the Decision Unit.
Total Lead in soil testing	ea	250	$7	$1,750	Confirmation sampling to verify XRF field data.
			Subtotal	**$204,750.00**	
Disposal Costs					
Disposal of LBP	ea	75	$800	$60,000	Assumes the generation of 75 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
			Subtotal	**$60,000.00**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333.33**	
Reporting and Project Management					
Project management and administration	ls	1	$65,000	$65,000	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$85,000.00**	
			Project Subtotal	$1,416,149	
			15% Contingency	$212,422	
			DECISION UNIT 9 - ALTERNATIVE 4 TOTAL	**$1,628,571**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

TABLE 59

ENGINEERING ESTIMATE - DECISION UNIT 9

ALTERNATIVE 5 - Abatement of lead for the exterior of the structures with limited excavation of soils and the installation of a geomembrane and a soil cap. Off-site disposal of contaminated soils.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE

Activity	Unit	Amount	Unit Cost	Extended Cost	Assumptions/ Estimate Source
Shared Project Costs					
Shared project costs for all Alternatives	ls	1	$123,591	$123,591	Includes 11 percent of the shared project costs listed on Table 18 (costs split between the nine Decision Units).
Shared project costs for Alternatives using off-site disposal	ls	1	$363,006	$363,006	Includes 11 percent of the shared project costs listed on Table 21 (costs split between the nine Decision Units).
			Subtotal	**$486,596**	
Mobilization/Demobilization of Personnel from CONUS to Midway Island					
Travel Per Diem - LBP and ACM abatement crew	ea	6	$3,450	$20,700	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - site supervisor	ea	1	$3,450	$3,450	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - painting crew	ea	3	$3,450	$10,350	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
Travel Per Diem - excavation and demolition crew	ea	7	$3,450	$24,150	Assumes $1,000 airfare from CONUS to Honolulu, Hawaii and $2,000 for flight to Midway. Includes $150 baggage fees and $300 per diem in Honolulu, Hawaii.
			Subtotal	**$58,650.00**	
Field Activities - Project Crew Costs					
LBP crew labor	hr	4,800	$80	$384,000	Assumes 100 days to abate the loose and flaky lead based paint from exterior of buildings.
Excavation crew labor	hr	840	$80	$67,200	Excavation of contaminated soils. Assumes the removal of 6,000 cubic yards of soil will take 15 days to complete.
Excavation and demolition crew labor	hr	1,120	$80	$89,600	Placement of excavated materials and debris at staging area. Assumes 20 days to complete.
Excavation crew labor	hr	2,240	$80	$179,200	Placement of geotextile and backfilling of excavation. Assumes the backfilling of the excavation with 18,000 cubic yards will take 40 days to complete.
Paint crew labor	hr	600	$75	$45,000	Assumes 25 days to paint all buildings.
Site supervisor labor	hr	1,300	$100	$130,000	Assumes 130 days to complete work at Decision Unit 9.
Midway lodging per diem	ea	650	$125	$81,250	Assumes two crew per room for lodging.
Midway meals per diem	ea	1,300	$50	$65,000	
			Subtotal	**$1,041,250**	
Field Activities - Equipment and Laboratory Costs					
On-island equipment rental	day	110	$2,000	$220,000	Rental of 10 yard dump truck, trackhoe excavator, backhoe and other heavy equipment from FWS.
Encapsulation paint costs	gal	200	$35	$7,000	Cost of paint for Buildings with EcoBond by MT2.
Excavation area liner costs	sf	175,000	$0.32	$56,000	Assumes the lining of an area 50 feet out from each building footprint in the Decision Unit.
Total Lead in soil testing	ea	250	$7	$1,750	Confirmation sampling to verify XRF field data.
			Subtotal	**$284,750**	
Disposal Costs					
Disposal of LBP	ea	75	$800	$60,000	Assumes the generation of 75 55-gallon drums of LBP chips. Also assumes the drums can be stored on site and transported to Honolulu, Hawaii on a dedicated shipment at the end of all Decision Unit work. Once material is in Honolulu, will be freight shipped to CONUS for disposal.
Disposal of soil in CONUS	ton	8,400	$50	$420,000	Assumes a 1.4 cubic yard per ton conversion. Assumed 6,000 cubic yards of soil.
			Subtotal	**$480,000**	
Operation and Maintenance Costs					
Annual inspection and reporting for Year 1 through 30	ea	30	$12,000.00	$40,000	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
5 year reviews in Years 5, 10, 15, 20, 25 and 30	ls	6	$5,000.00	$3,333	Assumes one report for the entire site (all 9 Decision Units). Listed price is 11% of the estimated yearly costs (split between the 9 Decision Units).
			Subtotal	**$43,333.33**	
Reporting and Project Management					
Project management and administration	ls	1	$120,000	$120,000	Assumes approximately 5% of the estimated project total without contingency.
Closeout report	ls	1	$20,000	$20,000	
			Subtotal	**$140,000**	
			Project Subtotal	$2,534,579	
			15% Contingency	$380,187	
			DECISION UNIT 9 - ALTERNATIVE 5 TOTAL	**$2,914,766**	

Other Assumptions:

Costs were derived from cost assemblies in Means 2003, vendor quotes and GeoEngineers previous project experience.

Notes:

sf = square foot
hr = hour
ea = each
gal = gallon
CONUS = Continental United States
LBP = lead-based paint
ACM = asbestos-containing material
XRF = X-Ray Fluorescence Testing

FIGURES

GeoEngineers

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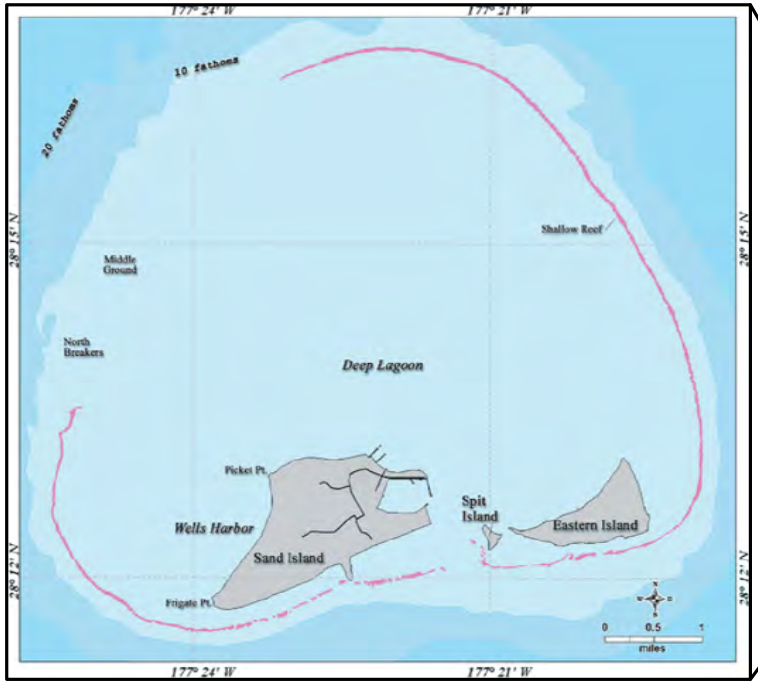
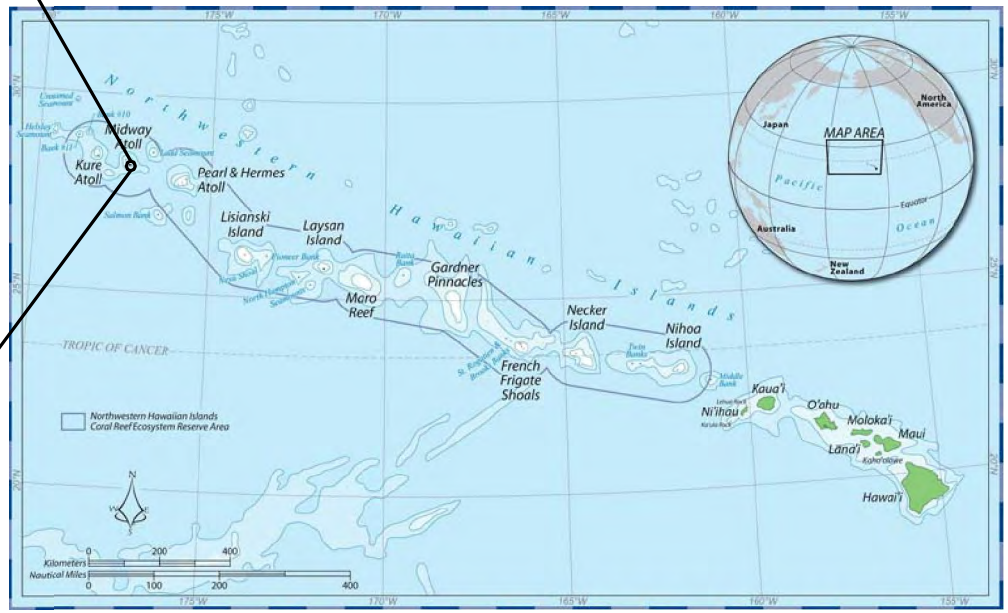




Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

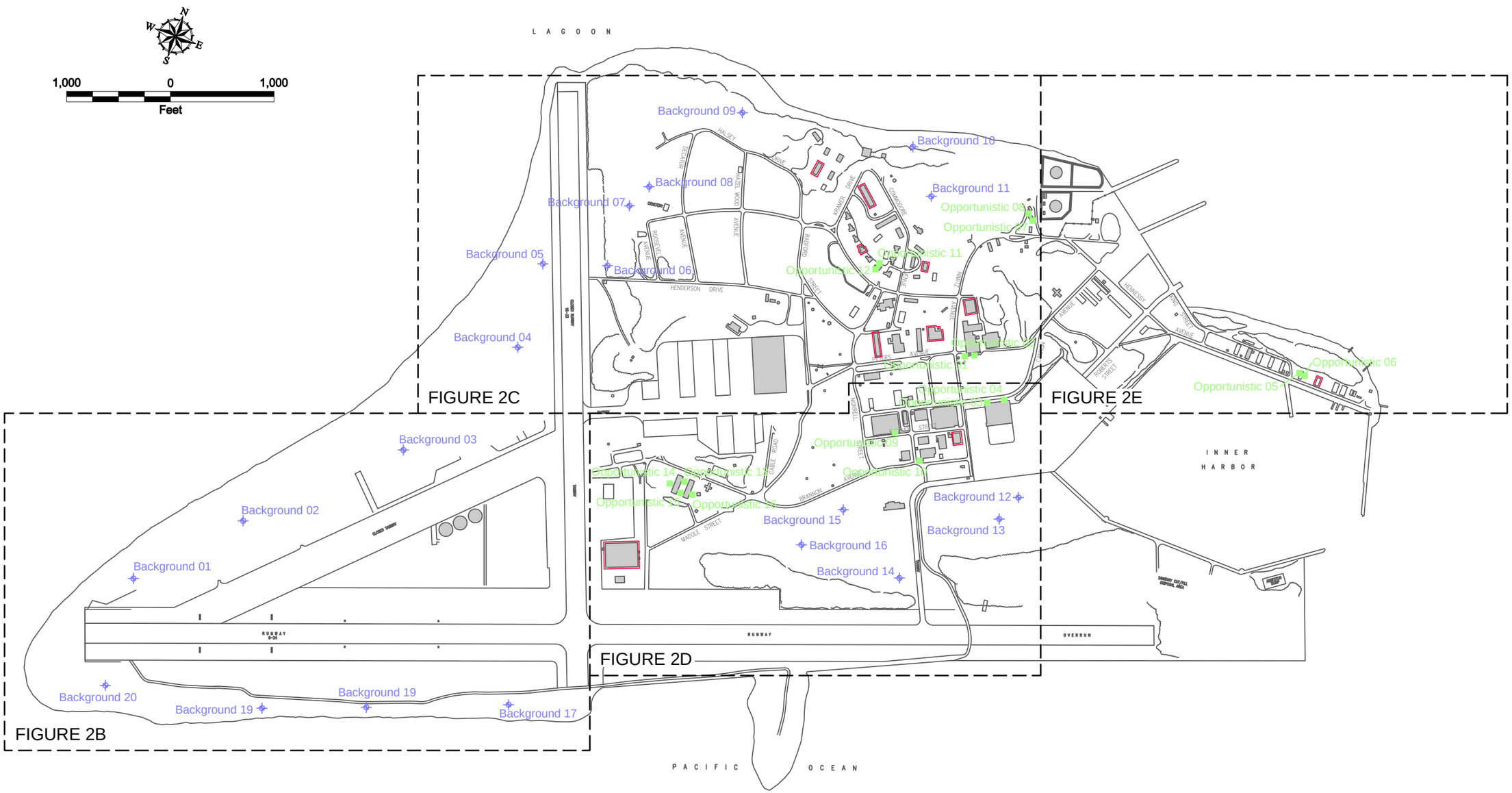
Reference: Unknown.

Vicinity Map

USFWS - Midway Atoll
Midway Island

GEOENGINEERS

Figure 1



Notes:
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Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

LEGEND:

- STRUCTURE
- AREAS SAMPLED BY GEOENGINEERS
- BACKGROUND SAMPLE LOCATION
- OPPORTUNISTIC SAMPLE LOCATION

Overall Site Plan with Select Sample Locations

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 2

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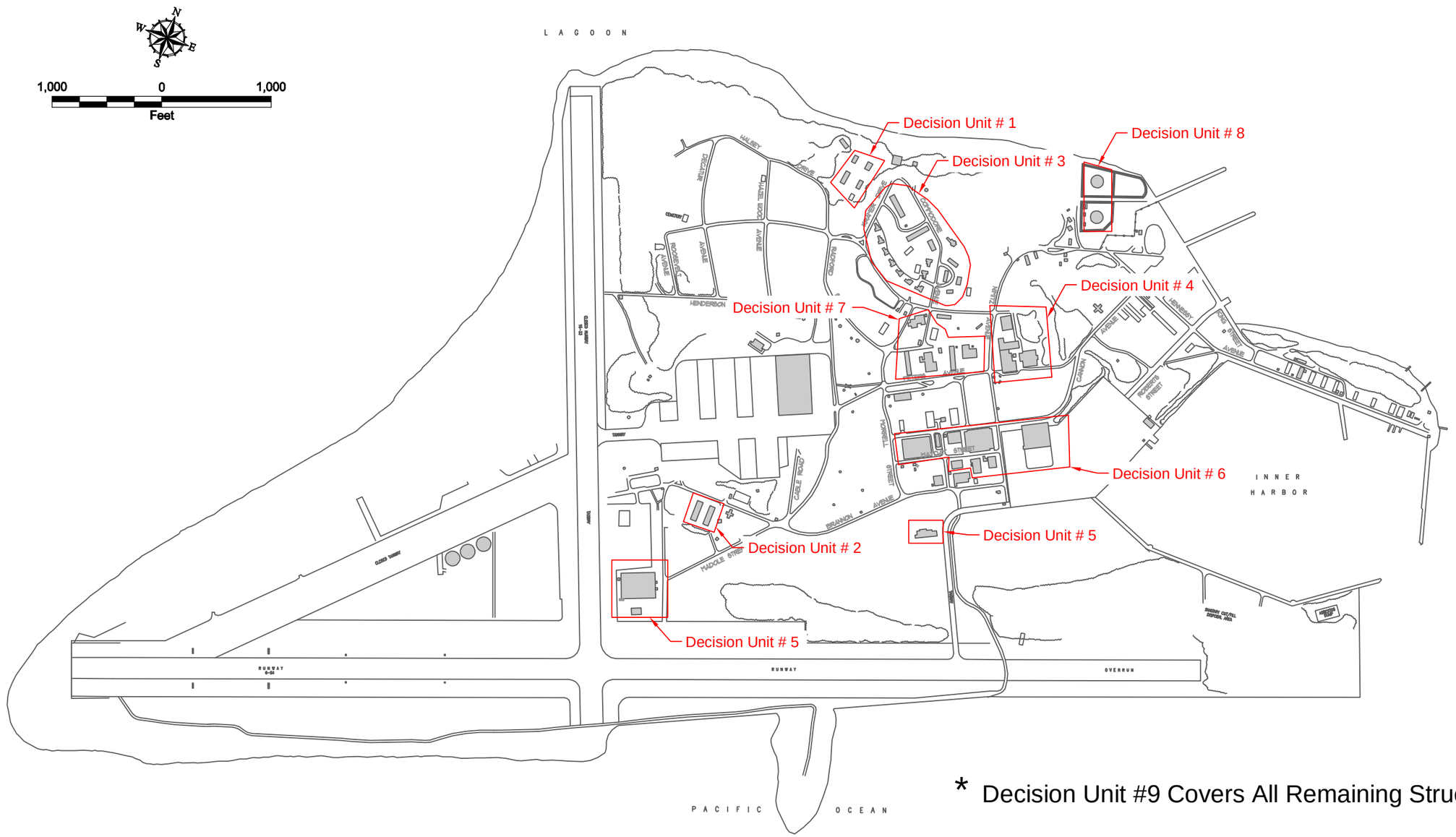

* Decision Unit #9 Covers All Remaining Structures.

Notes:
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Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

LEGEND:

STRUCTURE

DECISION UNIT

Overall Site Plan with Decision Units

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 2A

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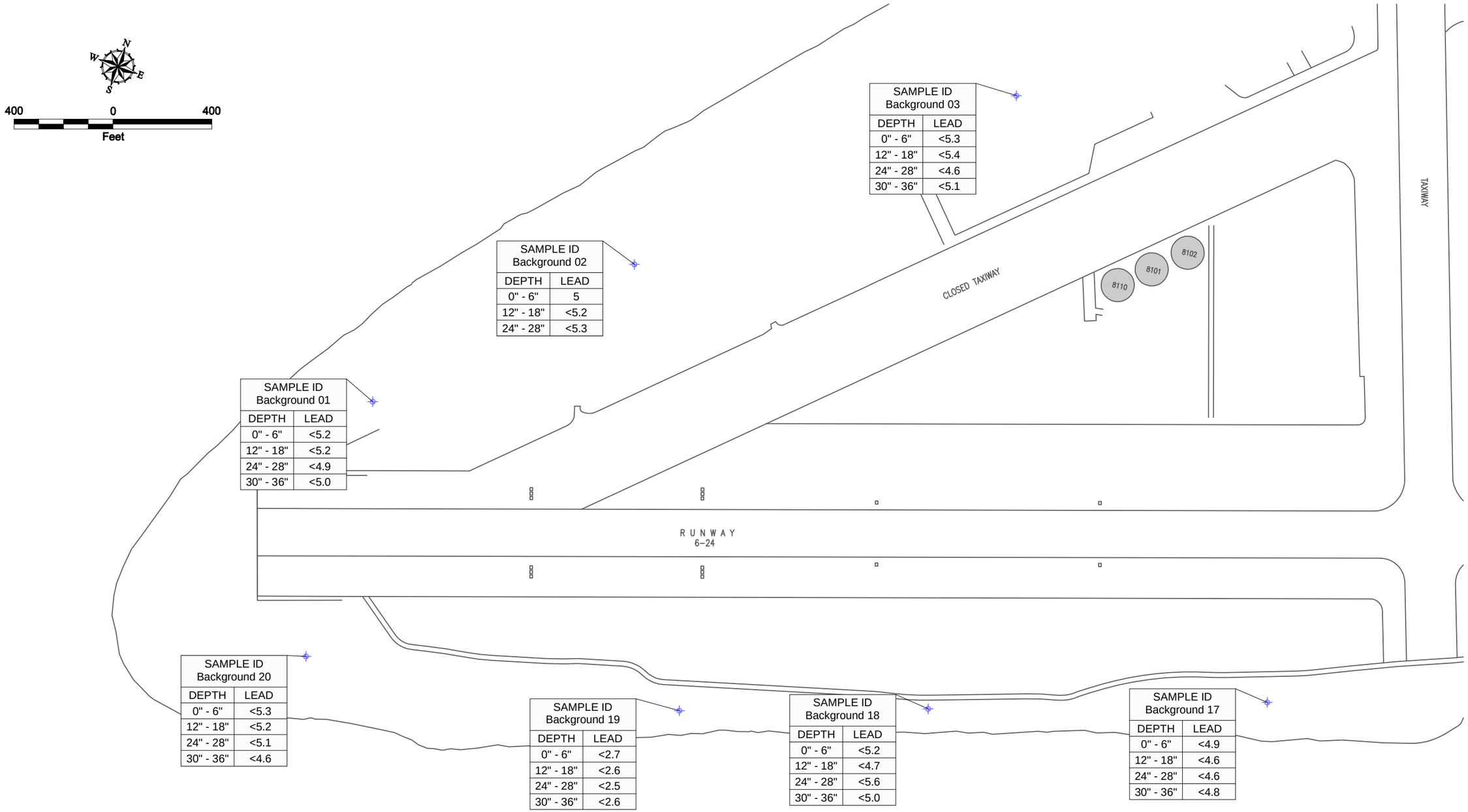

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24" - 28"	<4.6
30" - 36"	<5.1

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12" - 18"	<5.2
24" - 28"	<5.3

SAMPLE ID Background 01	
DEPTH	LEAD
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12" - 18"	<5.2
24" - 28"	<4.9
30" - 36"	<5.0

SAMPLE ID Background 20	
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12" - 18"	<5.2
24" - 28"	<5.1
30" - 36"	<4.6

SAMPLE ID Background 19	
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24" - 28"	<5.6
30" - 36"	<5.0

SAMPLE ID Background 17	
DEPTH	LEAD
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12" - 18"	<4.6
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30" - 36"	<4.8

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

LEGEND:

BACKGROUND SAMPLE LOCATION

Site Plan

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 2B

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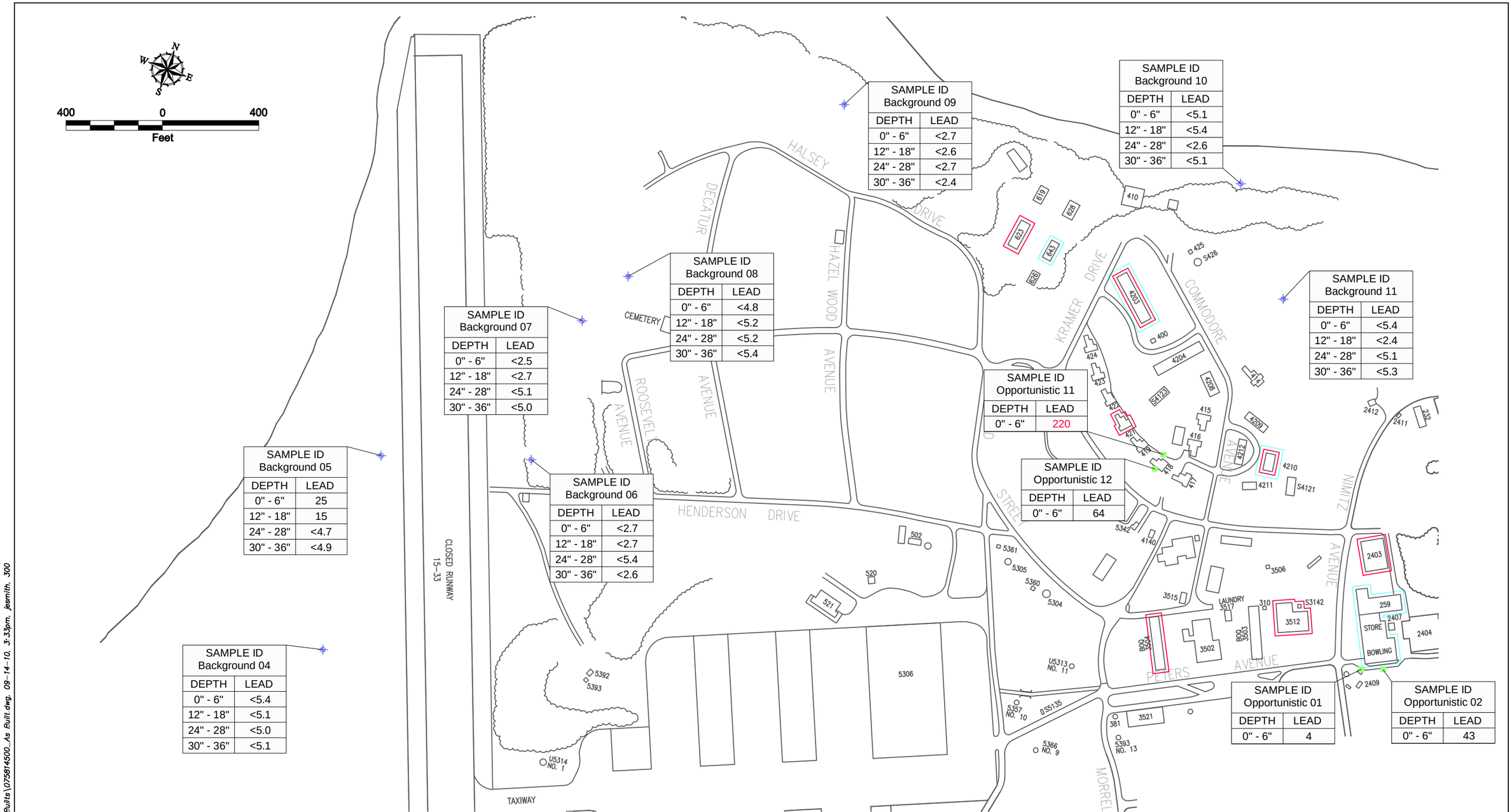

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

All lead concentrations reported in milligrams per kilogram (mg/kg).

Red indicates levels detected above the preliminary cleanup goal of 75 mg/kg.

LEGEND:

- GEOENGINEERS SAMPLING AREAS
- SOILS AROUND STRUCTURE SAMPLED BY US FISH AND WILDLIFE SERVICE IN 2009
- BACKGROUND SAMPLE LOCATION
- OPPORTUNISTIC SAMPLE LOCATION

Site Plan

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 2C

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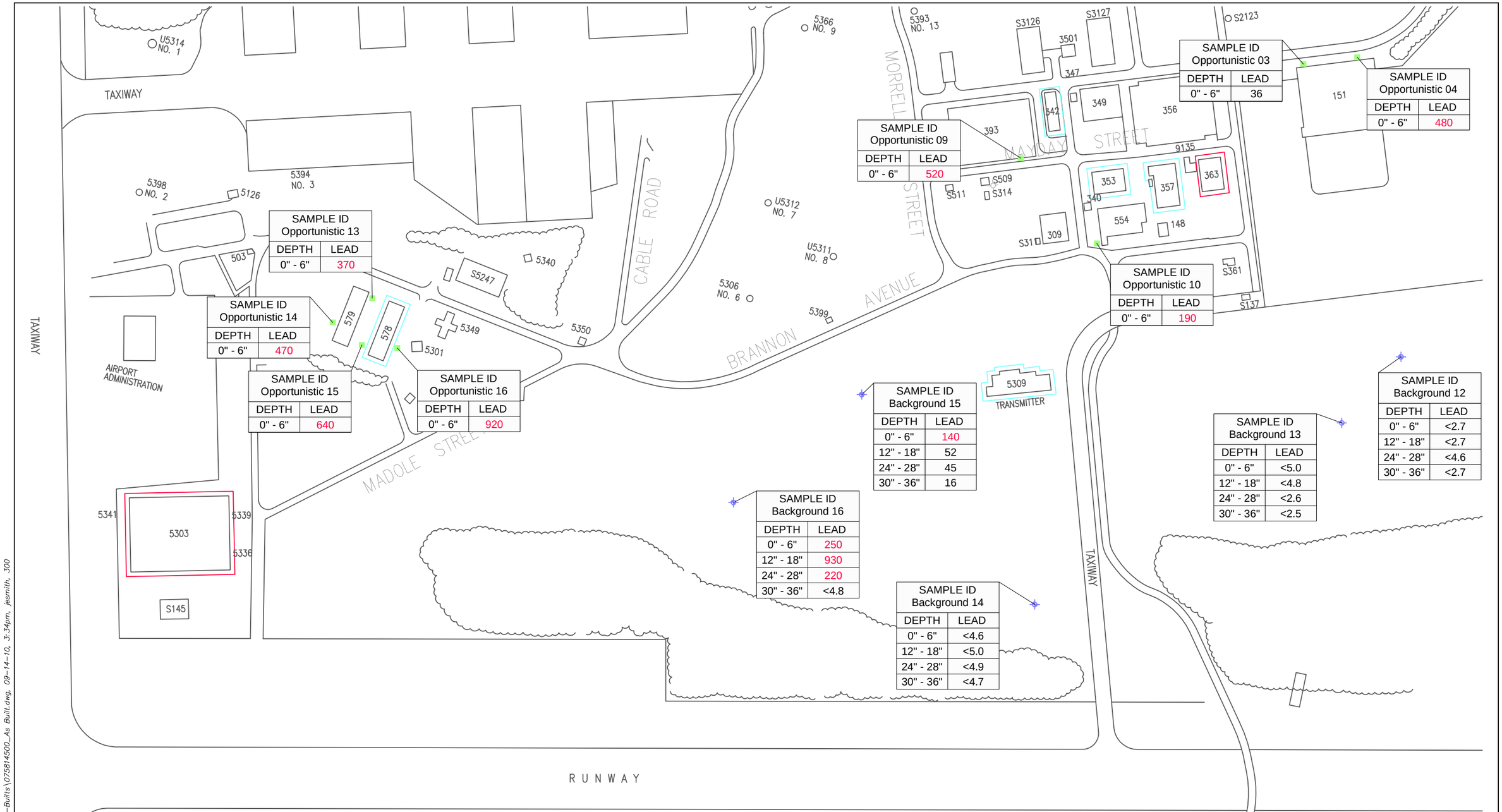

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SAMPLE ID Opportunistic 04

DEPTH	LEAD
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SAMPLE ID Opportunistic 09

DEPTH	LEAD
0" - 6"	520

SAMPLE ID Opportunistic 13

DEPTH	LEAD
0" - 6"	370

SAMPLE ID Opportunistic 14

DEPTH	LEAD
0" - 6"	470

SAMPLE ID Opportunistic 15

DEPTH	LEAD
0" - 6"	640

SAMPLE ID Opportunistic 16

DEPTH	LEAD
0" - 6"	920

SAMPLE ID Opportunistic 10

DEPTH	LEAD
0" - 6"	190

SAMPLE ID Background 15

DEPTH	LEAD
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12" - 18"	52
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30" - 36"	16

SAMPLE ID Background 13

DEPTH	LEAD
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12" - 18"	<4.8
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SAMPLE ID Background 12

DEPTH	LEAD
0" - 6"	<2.7
12" - 18"	<2.7
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30" - 36"	<2.7

SAMPLE ID Background 16

DEPTH	LEAD
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12" - 18"	930
24" - 28"	220
30" - 36"	<4.8

SAMPLE ID Background 14

DEPTH	LEAD
0" - 6"	<4.6
12" - 18"	<5.0
24" - 28"	<4.9
30" - 36"	<4.7

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

All lead concentrations reported in milligrams per kilogram (mg/kg).

Red indicates levels detected above the preliminary cleanup goal of 75 mg/kg.

LEGEND:

- GEOENGINEERS SAMPLING AREAS
- SOILS AROUND STRUCTURE SAMPLED BY US FISH AND WILDLIFE SERVICE IN 2009
- BACKGROUND SAMPLE LOCATION
- OPPORTUNISTIC SAMPLE LOCATION

N W E S

300 0 300
Feet

Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

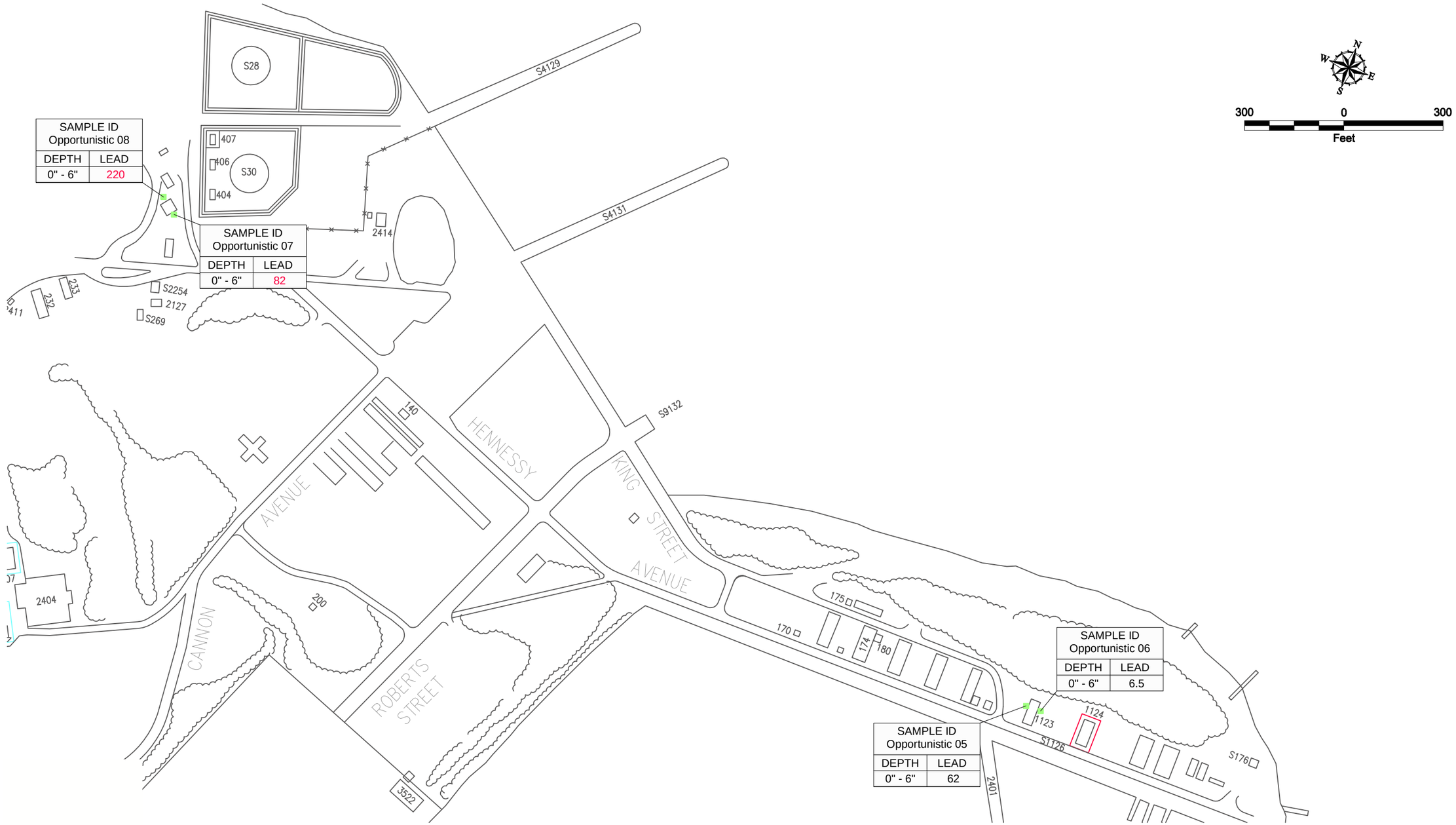
Site Plan

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 2D

\\pdx\projects\0\0758145\00\Cad\As-Builts\0758145 00_As Built.dwg, 09-14-10, 3:34pm, jesmith, 300



Notes:
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2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

All lead concentrations reported in milligrams per kilogram (mg/kg).

Red indicates levels detected above the preliminary cleanup goal of 75 mg/kg.

LEGEND:

GEOENGINEERS SAMPLING AREAS

OPPORTUNISTIC SAMPLE LOCATION

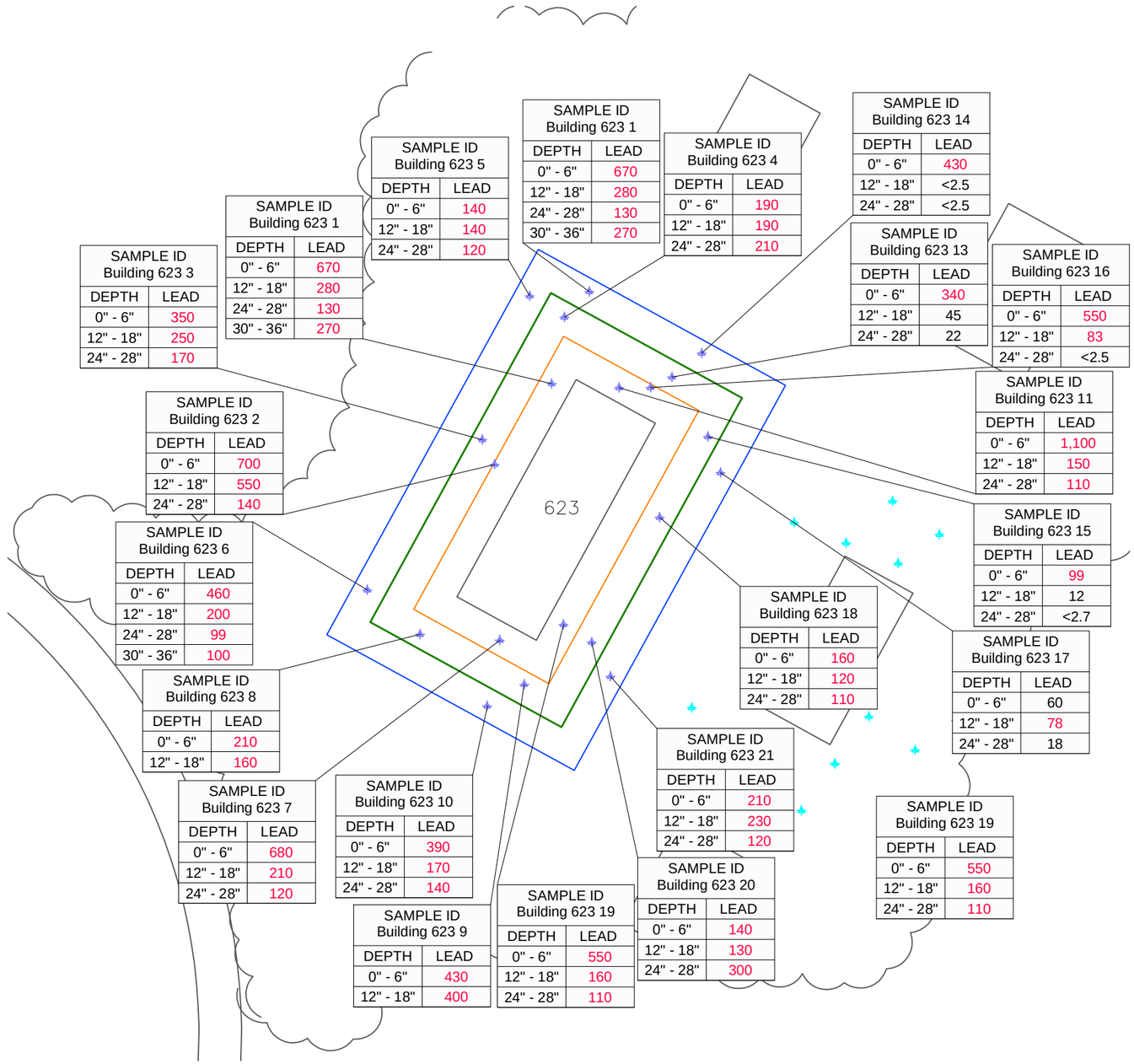
Site Plan

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 2E

\\pdx\projects\0\0758145\00\Cad\As-Builts\075814500_As Built.dwg, 09-14-10, 3:34pm, jesmith, 300



SAMPLE ID Building 623 3

DEPTH	LEAD
0" - 6"	350
12" - 18"	250
24" - 28"	170

SAMPLE ID Building 623 1

DEPTH	LEAD
0" - 6"	670
12" - 18"	280
24" - 28"	130
30" - 36"	270

SAMPLE ID Building 623 5

DEPTH	LEAD
0" - 6"	140
12" - 18"	140
24" - 28"	120

SAMPLE ID Building 623 1

DEPTH	LEAD
0" - 6"	670
12" - 18"	280
24" - 28"	130
30" - 36"	270

SAMPLE ID Building 623 4

DEPTH	LEAD
0" - 6"	190
12" - 18"	190
24" - 28"	210

SAMPLE ID Building 623 14

DEPTH	LEAD
0" - 6"	430
12" - 18"	<2.5
24" - 28"	<2.5

SAMPLE ID Building 623 13

DEPTH	LEAD
0" - 6"	340
12" - 18"	45
24" - 28"	22

SAMPLE ID Building 623 16

DEPTH	LEAD
0" - 6"	550
12" - 18"	83
24" - 28"	<2.5

SAMPLE ID Building 623 11

DEPTH	LEAD
0" - 6"	1,100
12" - 18"	150
24" - 28"	110

SAMPLE ID Building 623 2

DEPTH	LEAD
0" - 6"	700
12" - 18"	550
24" - 28"	140

SAMPLE ID Building 623 6

DEPTH	LEAD
0" - 6"	460
12" - 18"	200
24" - 28"	99
30" - 36"	100

SAMPLE ID Building 623 15

DEPTH	LEAD
0" - 6"	99
12" - 18"	12
24" - 28"	<2.7

SAMPLE ID Building 623 18

DEPTH	LEAD
0" - 6"	160
12" - 18"	120
24" - 28"	110

SAMPLE ID Building 623 17

DEPTH	LEAD
0" - 6"	60
12" - 18"	78
24" - 28"	18

SAMPLE ID Building 623 8

DEPTH	LEAD
0" - 6"	210
12" - 18"	160

SAMPLE ID Building 623 21

DEPTH	LEAD
0" - 6"	210
12" - 18"	230
24" - 28"	120

SAMPLE ID Building 623 7

DEPTH	LEAD
0" - 6"	680
12" - 18"	210
24" - 28"	120

SAMPLE ID Building 623 10

DEPTH	LEAD
0" - 6"	390
12" - 18"	170
24" - 28"	140

SAMPLE ID Building 623 19

DEPTH	LEAD
0" - 6"	550
12" - 18"	160
24" - 28"	110

SAMPLE ID Building 623 20

DEPTH	LEAD
0" - 6"	140
12" - 18"	130
24" - 28"	300

SAMPLE ID Building 623 9

DEPTH	LEAD
0" - 6"	430
12" - 18"	400

SAMPLE ID Building 623 19

DEPTH	LEAD
0" - 6"	550
12" - 18"	160
24" - 28"	110

LEGEND:

- 15' sampling area
- 30' sampling area
- 45' sampling area
- Sample Location GeoEngineers
- Sample Location FWS

For lead data in FWS samples see Figure 4.

All lead concentrations reported in milligrams per kilogram (mg/kg).

Red indicates levels detected above the preliminary cleanup goal of 75 mg/kg.

N W E S

60 0 60
Feet

Notes:
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2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

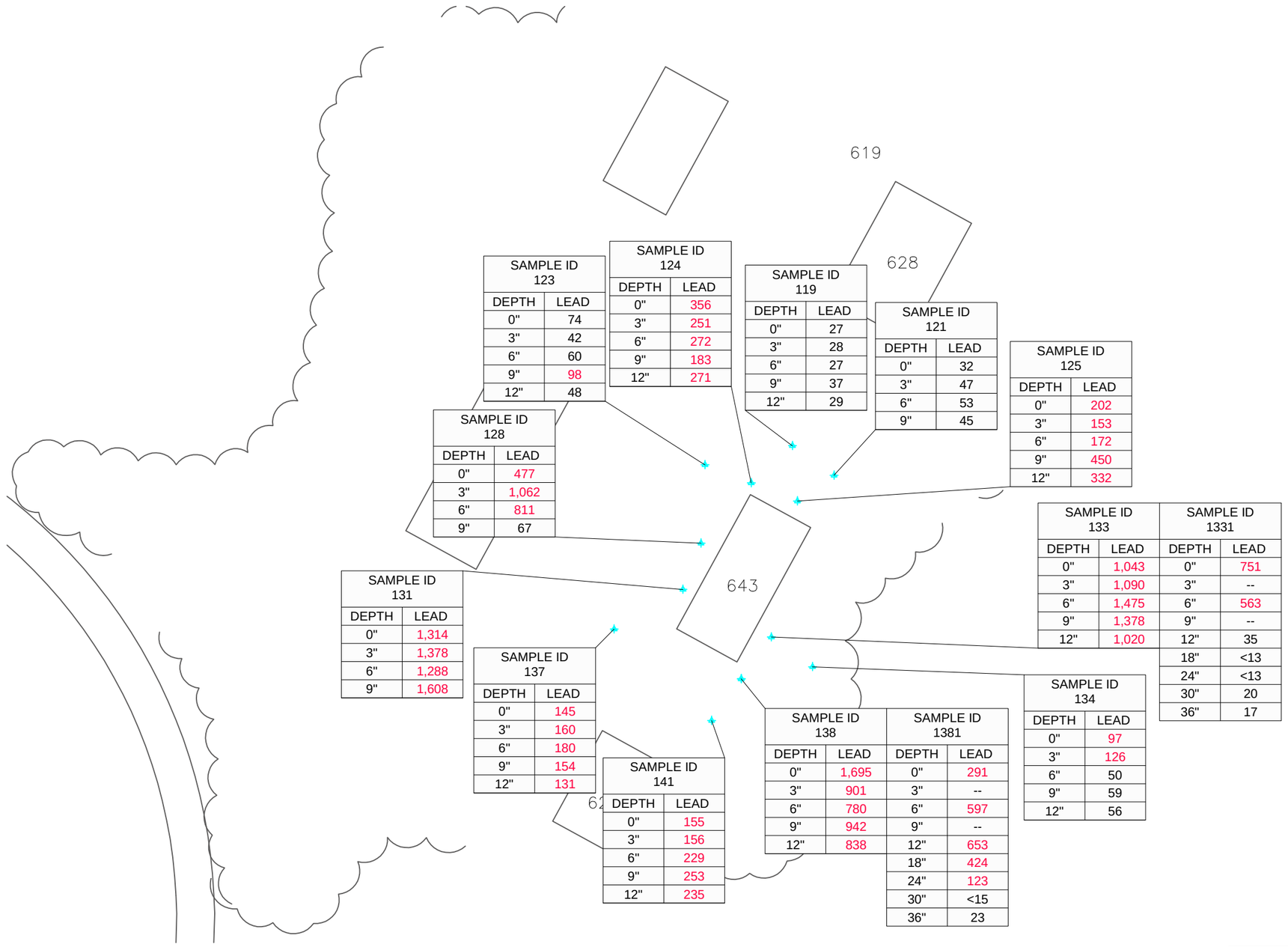
Building #623 Sample Locations
Decision Unit 1

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 3

\\pdx\projects\0\0758145\00\Cad\As-Builts\075814500_As Built.dwg, 09-14-10, 3:35pm, jasmith, 300



SAMPLE ID 123	
DEPTH	LEAD
0"	74
3"	42
6"	60
9"	98
12"	48

SAMPLE ID 124	
DEPTH	LEAD
0"	356
3"	251
6"	272
9"	183
12"	271

SAMPLE ID 119	
DEPTH	LEAD
0"	27
3"	28
6"	27
9"	37
12"	29

SAMPLE ID 121	
DEPTH	LEAD
0"	32
3"	47
6"	53
9"	45

SAMPLE ID 125	
DEPTH	LEAD
0"	202
3"	153
6"	172
9"	450
12"	332

SAMPLE ID 128	
DEPTH	LEAD
0"	477
3"	1,062
6"	811
9"	67

SAMPLE ID 133		SAMPLE ID 1331	
DEPTH	LEAD	DEPTH	LEAD
0"	1,043	0"	751
3"	1,090	3"	--
6"	1,475	6"	563
9"	1,378	9"	--
12"	1,020	12"	35
		18"	<13
		24"	<13
		30"	20
		36"	17

SAMPLE ID 131	
DEPTH	LEAD
0"	1,314
3"	1,378
6"	1,288
9"	1,608

SAMPLE ID 137	
DEPTH	LEAD
0"	145
3"	160
6"	180
9"	154
12"	131

SAMPLE ID 134	
DEPTH	LEAD
0"	97
3"	126
6"	50
9"	59
12"	56

SAMPLE ID 138	
DEPTH	LEAD
0"	1,695
3"	901
6"	780
9"	942
12"	838

SAMPLE ID 1381	
DEPTH	LEAD
0"	291
3"	--
6"	597
9"	--
12"	653
18"	424
24"	123
30"	<15
36"	23

SAMPLE ID 141	
DEPTH	LEAD
0"	155
3"	156
6"	229
9"	253
12"	235

LEGEND:

Sample Location FWS

All lead concentrations reported in milligrams per kilogram (mg/kg).

Red indicates levels detected above the preliminary cleanup goal of 75 mg/kg.

N W E S

60 0 60
Feet

Notes:
1. The locations of all features shown are approximate.
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Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

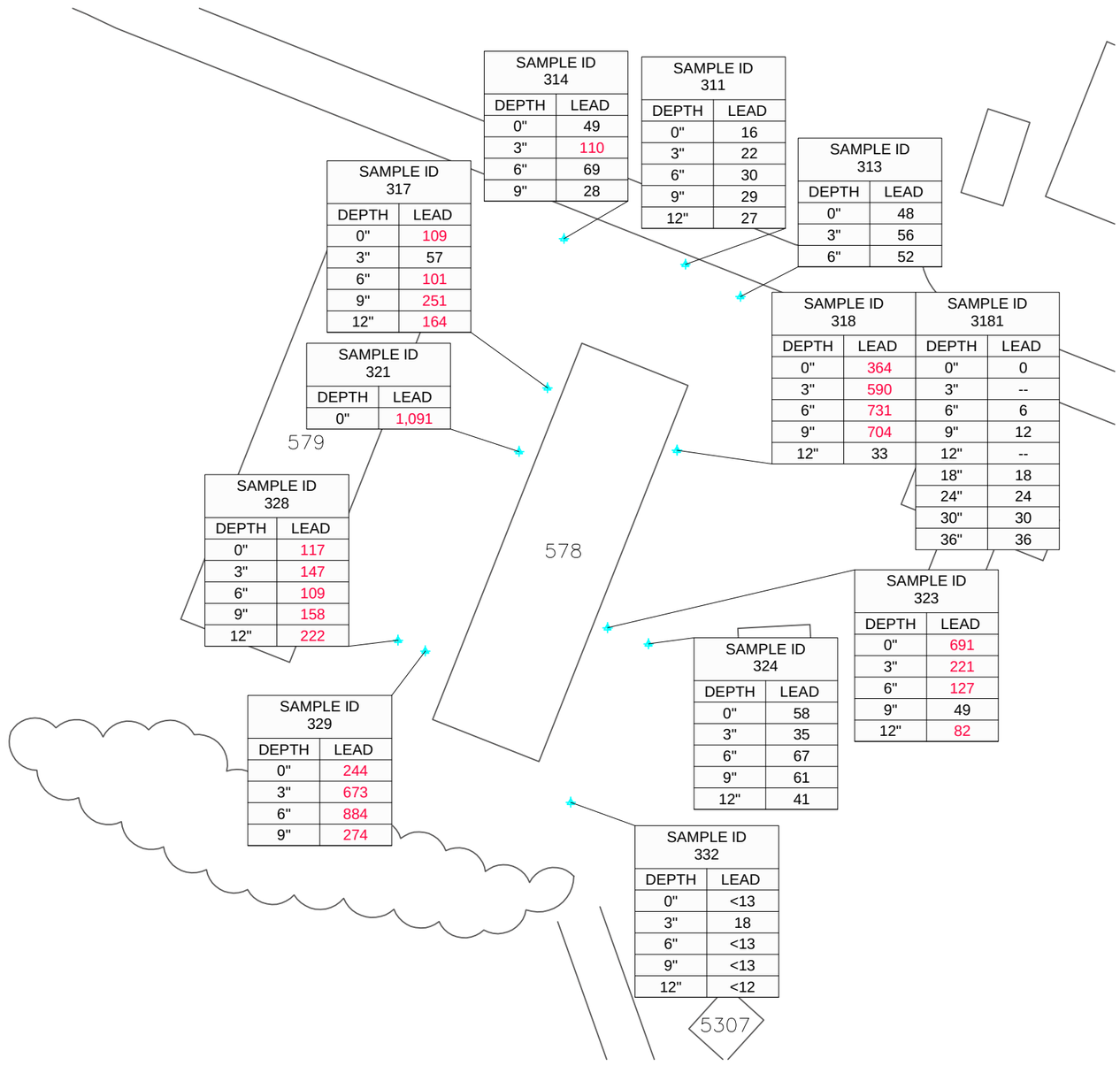
Building #643 Sample Locations
Decision Unit 1

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 4

\\pdx\projects\0\0758145\00\Cad\As-Builts\075814500_As Built.dwg, 09-14-10, 3:35pm, jesmith, 300



SAMPLE ID 314	
DEPTH	LEAD
0"	49
3"	110
6"	69
9"	28

SAMPLE ID 311	
DEPTH	LEAD
0"	16
3"	22
6"	30
9"	29
12"	27

SAMPLE ID 313	
DEPTH	LEAD
0"	48
3"	56
6"	52

SAMPLE ID 317	
DEPTH	LEAD
0"	109
3"	57
6"	101
9"	251
12"	164

SAMPLE ID 321	
DEPTH	LEAD
0"	1,091

SAMPLE ID 318		SAMPLE ID 3181	
DEPTH	LEAD	DEPTH	LEAD
0"	364	0"	0
3"	590	3"	--
6"	731	6"	6
9"	704	9"	12
12"	33	12"	--
		18"	18
		24"	24
		30"	30
		36"	36

SAMPLE ID 328	
DEPTH	LEAD
0"	117
3"	147
6"	109
9"	158
12"	222

SAMPLE ID 323	
DEPTH	LEAD
0"	691
3"	221
6"	127
9"	49
12"	82

SAMPLE ID 324	
DEPTH	LEAD
0"	58
3"	35
6"	67
9"	61
12"	41

SAMPLE ID 329	
DEPTH	LEAD
0"	244
3"	673
6"	884
9"	274

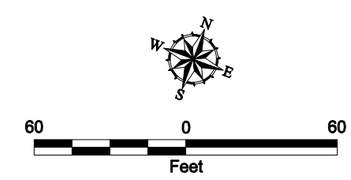
SAMPLE ID 332	
DEPTH	LEAD
0"	<13
3"	18
6"	<13
9"	<13
12"	<12

LEGEND:

Sample Location FWS

All lead concentrations reported in milligrams per kilogram (mg/kg).

Red indicates levels detected above the preliminary cleanup goal of 75 mg/kg.



Notes:
1. The locations of all features shown are approximate.
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Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

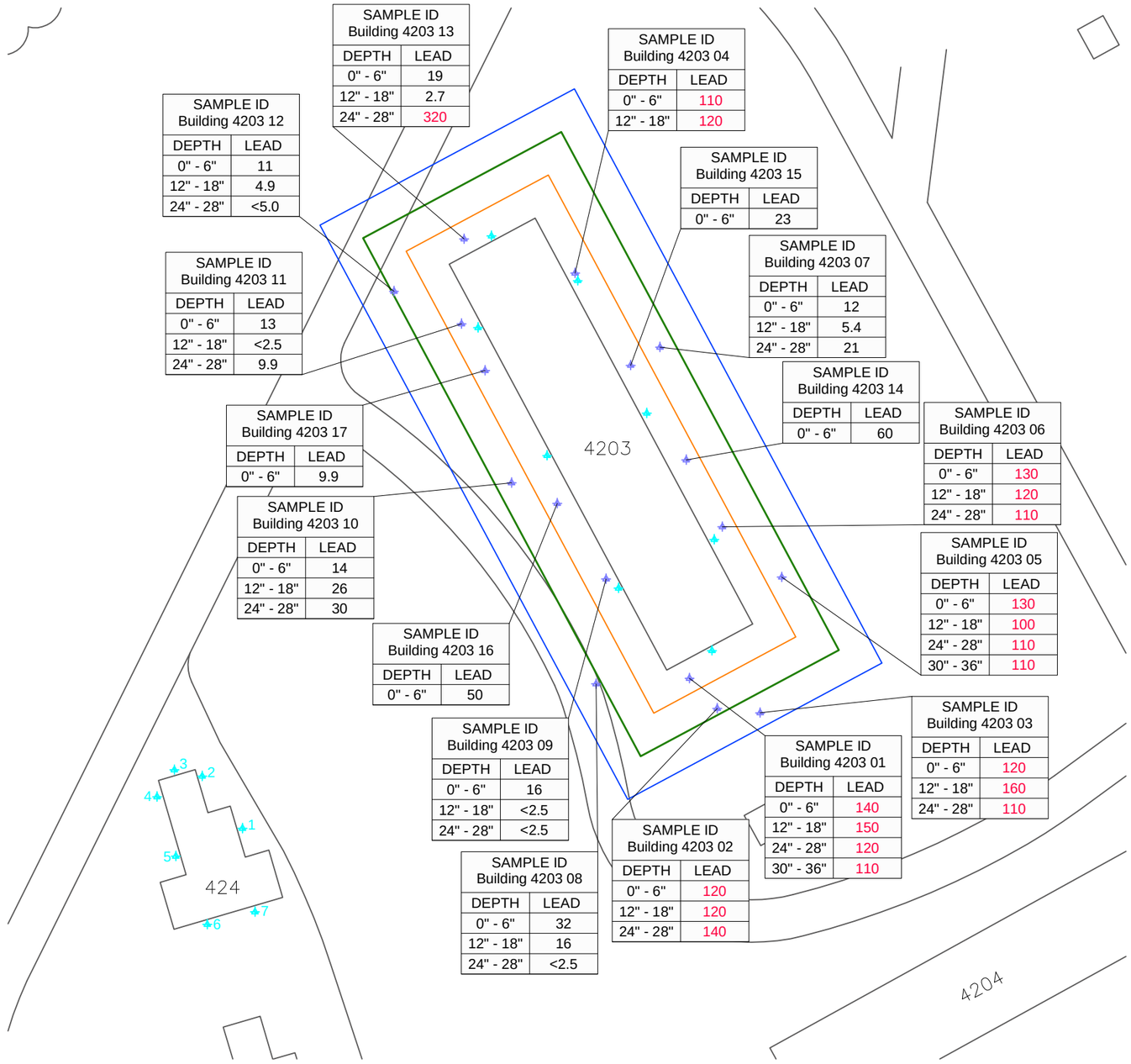
Building #578 Sample Locations
Decision Unit 2

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 5

\\pdx\projects\0\0758145\00\Cad\As-Builts\075814500_As Built.dwg, 09-14-10, 3:36pm, jesmith, 300



SAMPLE ID Building 4203 13

DEPTH	LEAD
0" - 6"	19
12" - 18"	2.7
24" - 28"	320

SAMPLE ID Building 4203 04

DEPTH	LEAD
0" - 6"	110
12" - 18"	120

SAMPLE ID Building 4203 12

DEPTH	LEAD
0" - 6"	11
12" - 18"	4.9
24" - 28"	<5.0

SAMPLE ID Building 4203 15

DEPTH	LEAD
0" - 6"	23

SAMPLE ID Building 4203 11

DEPTH	LEAD
0" - 6"	13
12" - 18"	<2.5
24" - 28"	9.9

SAMPLE ID Building 4203 07

DEPTH	LEAD
0" - 6"	12
12" - 18"	5.4
24" - 28"	21

SAMPLE ID Building 4203 14

DEPTH	LEAD
0" - 6"	60

SAMPLE ID Building 4203 17

DEPTH	LEAD
0" - 6"	9.9

SAMPLE ID Building 4203 06

DEPTH	LEAD
0" - 6"	130
12" - 18"	120
24" - 28"	110

SAMPLE ID Building 4203 10

DEPTH	LEAD
0" - 6"	14
12" - 18"	26
24" - 28"	30

SAMPLE ID Building 4203 05

DEPTH	LEAD
0" - 6"	130
12" - 18"	100
24" - 28"	110
30" - 36"	110

SAMPLE ID Building 4203 16

DEPTH	LEAD
0" - 6"	50

SAMPLE ID Building 4203 09

DEPTH	LEAD
0" - 6"	16
12" - 18"	<2.5
24" - 28"	<2.5

SAMPLE ID Building 4203 03

DEPTH	LEAD
0" - 6"	120
12" - 18"	160
24" - 28"	110

SAMPLE ID Building 4203 01

DEPTH	LEAD
0" - 6"	140
12" - 18"	150
24" - 28"	120
30" - 36"	110

SAMPLE ID Building 4203 02

DEPTH	LEAD
0" - 6"	120
12" - 18"	120
24" - 28"	140

SAMPLE ID Building 4203 08

DEPTH	LEAD
0" - 6"	32
12" - 18"	16
24" - 28"	<2.5

LEGEND:

- 15' sampling area
- 30' sampling area
- 45' sampling area
- Sample Location GeoEngineers
- Sample Location FWS

For lead data in FWS samples see Figure 7.

All lead concentrations reported in milligrams per kilogram (mg/kg).

Red indicates levels detected above the preliminary cleanup goal of 75 mg/kg.

N W E S

60 0 60
Feet

Notes:
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Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

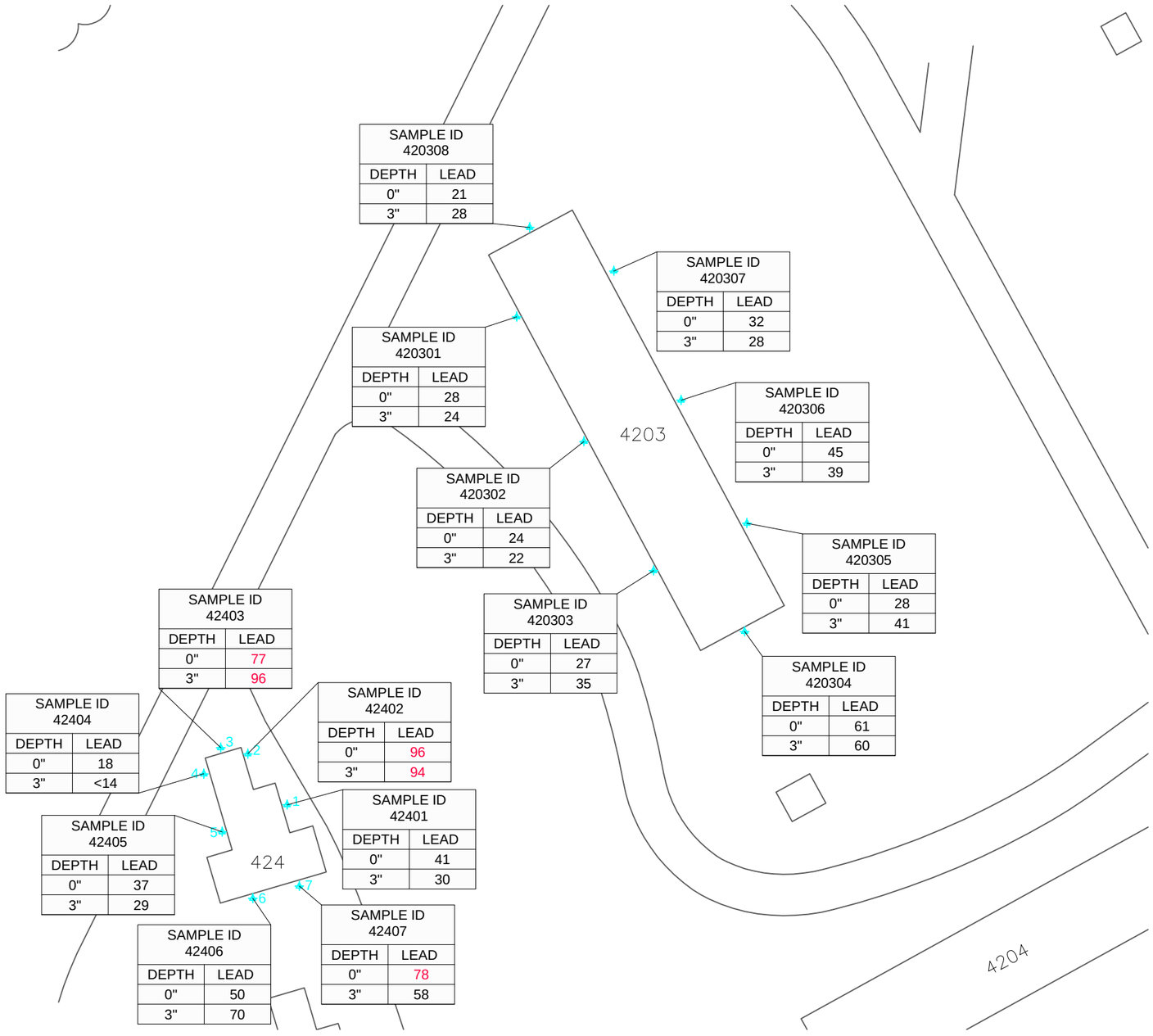
Building #4203 Sample Locations
Decision Unit 3

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 6

\\pdx\projects\0\0758145\00\Cad\As-Builts\075814500_As Built.dwg, 09-14-10, 3:36pm, jsmith, 300

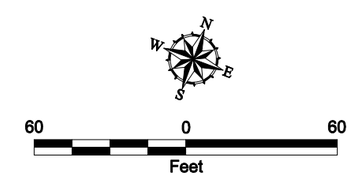


LEGEND:

Sample Location FWS

All lead concentrations reported in milligrams per kilogram (mg/kg).

Red indicates levels detected above the preliminary cleanup goal of 75 mg/kg.



Notes:
1. The locations of all features shown are approximate.
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Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

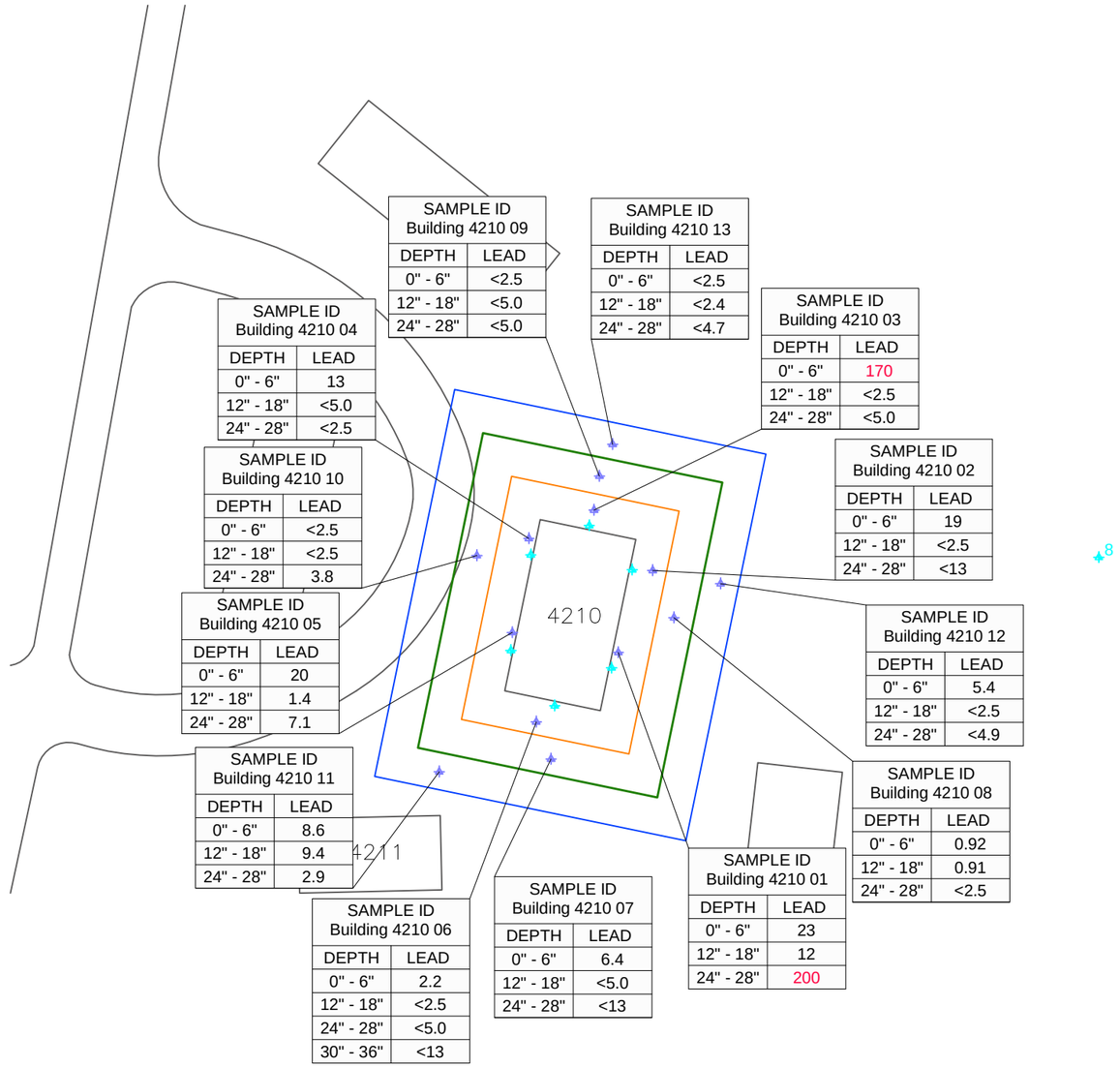
Building #4203 Sample Locations
Decision Unit 3

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 7

\\pdx\projects\0\0758145\00\Cad\As-Builts\075814500_As Built.dwg, 09-14-10, 3:37pm, jesmith, 300



SAMPLE ID Building 4210 09	
DEPTH	LEAD
0" - 6"	<2.5
12" - 18"	<5.0
24" - 28"	<5.0

SAMPLE ID Building 4210 13	
DEPTH	LEAD
0" - 6"	<2.5
12" - 18"	<2.4
24" - 28"	<4.7

SAMPLE ID Building 4210 04	
DEPTH	LEAD
0" - 6"	13
12" - 18"	<5.0
24" - 28"	<2.5

SAMPLE ID Building 4210 03	
DEPTH	LEAD
0" - 6"	170
12" - 18"	<2.5
24" - 28"	<5.0

SAMPLE ID Building 4210 10	
DEPTH	LEAD
0" - 6"	<2.5
12" - 18"	<2.5
24" - 28"	3.8

SAMPLE ID Building 4210 02	
DEPTH	LEAD
0" - 6"	19
12" - 18"	<2.5
24" - 28"	<13

SAMPLE ID Building 4210 05	
DEPTH	LEAD
0" - 6"	20
12" - 18"	1.4
24" - 28"	7.1

SAMPLE ID Building 4210 12	
DEPTH	LEAD
0" - 6"	5.4
12" - 18"	<2.5
24" - 28"	<4.9

SAMPLE ID Building 4210 11	
DEPTH	LEAD
0" - 6"	8.6
12" - 18"	9.4
24" - 28"	2.9

SAMPLE ID Building 4210 08	
DEPTH	LEAD
0" - 6"	0.92
12" - 18"	0.91
24" - 28"	<2.5

SAMPLE ID Building 4210 06	
DEPTH	LEAD
0" - 6"	2.2
12" - 18"	<2.5
24" - 28"	<5.0
30" - 36"	<13

SAMPLE ID Building 4210 07	
DEPTH	LEAD
0" - 6"	6.4
12" - 18"	<5.0
24" - 28"	<13

SAMPLE ID Building 4210 01	
DEPTH	LEAD
0" - 6"	23
12" - 18"	12
24" - 28"	200

LEGEND:

- 15' sampling area
- 30' sampling area
- 45' sampling area
- Sample Location GeoEngineers
- Sample Location FWS

For lead data in FWS samples see Figure 10.

All lead concentrations reported in milligrams per kilogram (mg/kg).

Red indicates levels detected above the preliminary cleanup goal of 75 mg/kg.

N W E S

60 0 60
Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

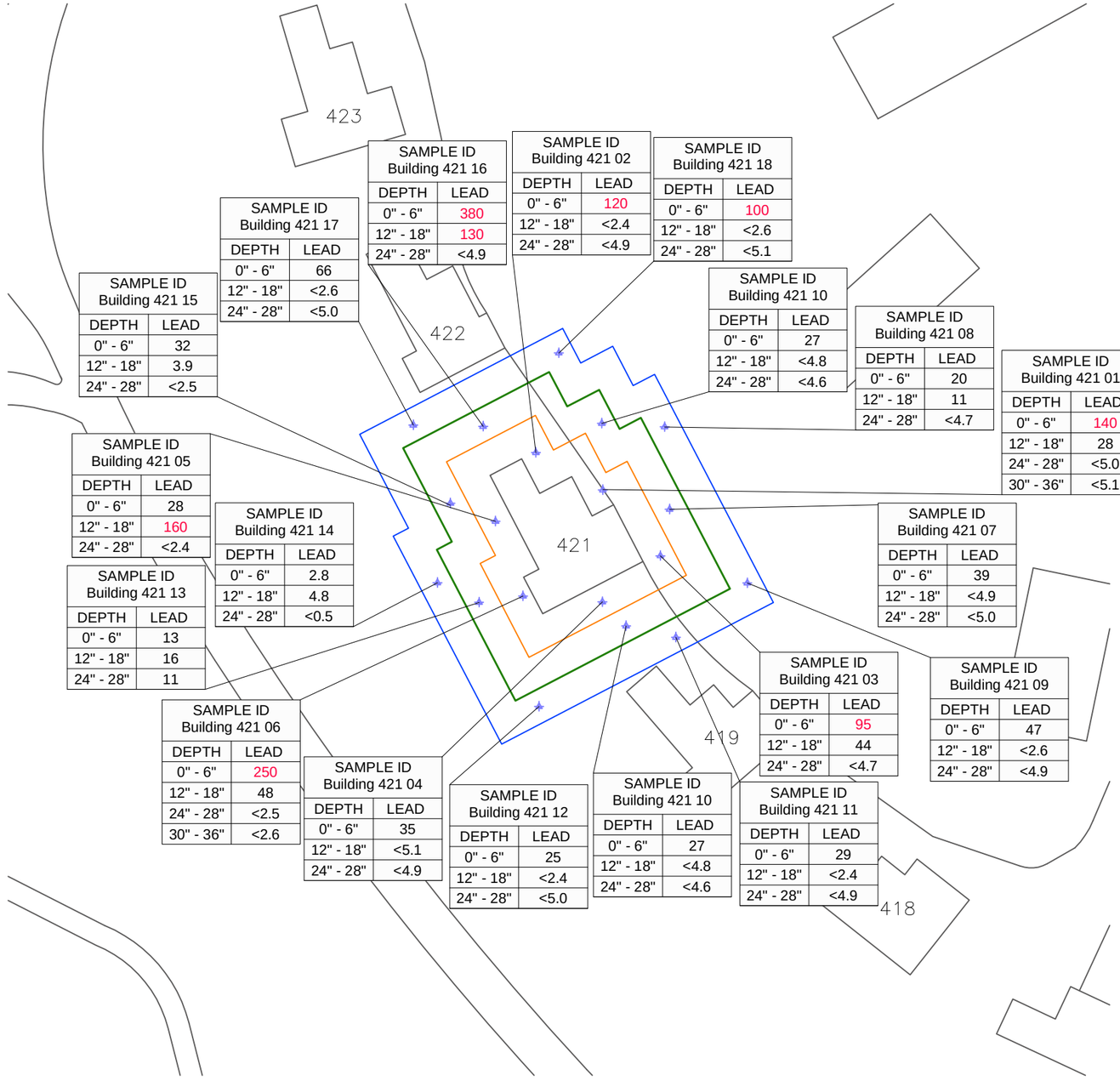
Building #4210 Sample Locations
Decision Unit 3

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 8

\\pdx\projects\0\0758145\00\Cad\As-Builts\0758145 00_As Built.dwg, 09-14-10, 3:37pm, jesmith, 300



SAMPLE ID Building 421 16

DEPTH	LEAD
0" - 6"	380
12" - 18"	130
24" - 28"	<4.9

SAMPLE ID Building 421 02

DEPTH	LEAD
0" - 6"	120
12" - 18"	<2.4
24" - 28"	<4.9

SAMPLE ID Building 421 18

DEPTH	LEAD
0" - 6"	100
12" - 18"	<2.6
24" - 28"	<5.1

SAMPLE ID Building 421 17

DEPTH	LEAD
0" - 6"	66
12" - 18"	<2.6
24" - 28"	<5.0

SAMPLE ID Building 421 15

DEPTH	LEAD
0" - 6"	32
12" - 18"	3.9
24" - 28"	<2.5

SAMPLE ID Building 421 10

DEPTH	LEAD
0" - 6"	27
12" - 18"	<4.8
24" - 28"	<4.6

SAMPLE ID Building 421 08

DEPTH	LEAD
0" - 6"	20
12" - 18"	11
24" - 28"	<4.7

SAMPLE ID Building 421 01

DEPTH	LEAD
0" - 6"	140
12" - 18"	28
24" - 28"	<5.0
30" - 36"	<5.1

SAMPLE ID Building 421 05

DEPTH	LEAD
0" - 6"	28
12" - 18"	160
24" - 28"	<2.4

SAMPLE ID Building 421 14

DEPTH	LEAD
0" - 6"	2.8
12" - 18"	4.8
24" - 28"	<0.5

SAMPLE ID Building 421 07

DEPTH	LEAD
0" - 6"	39
12" - 18"	<4.9
24" - 28"	<5.0

SAMPLE ID Building 421 13

DEPTH	LEAD
0" - 6"	13
12" - 18"	16
24" - 28"	11

SAMPLE ID Building 421 03

DEPTH	LEAD
0" - 6"	95
12" - 18"	44
24" - 28"	<4.7

SAMPLE ID Building 421 09

DEPTH	LEAD
0" - 6"	47
12" - 18"	<2.6
24" - 28"	<4.9

SAMPLE ID Building 421 06

DEPTH	LEAD
0" - 6"	250
12" - 18"	48
24" - 28"	<2.5
30" - 36"	<2.6

SAMPLE ID Building 421 04

DEPTH	LEAD
0" - 6"	35
12" - 18"	<5.1
24" - 28"	<4.9

SAMPLE ID Building 421 12

DEPTH	LEAD
0" - 6"	25
12" - 18"	<2.4
24" - 28"	<5.0

SAMPLE ID Building 421 10

DEPTH	LEAD
0" - 6"	27
12" - 18"	<4.8
24" - 28"	<4.6

SAMPLE ID Building 421 11

DEPTH	LEAD
0" - 6"	29
12" - 18"	<2.4
24" - 28"	<4.9

LEGEND:

- 15' sampling area
- 30' sampling area
- 45' sampling area
- Sample Location GeoEngineers

All lead concentrations reported in milligrams per kilogram (mg/kg).

Red indicates levels detected above the preliminary cleanup goal of 75 mg/kg.

N W E S

60 0 60
Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

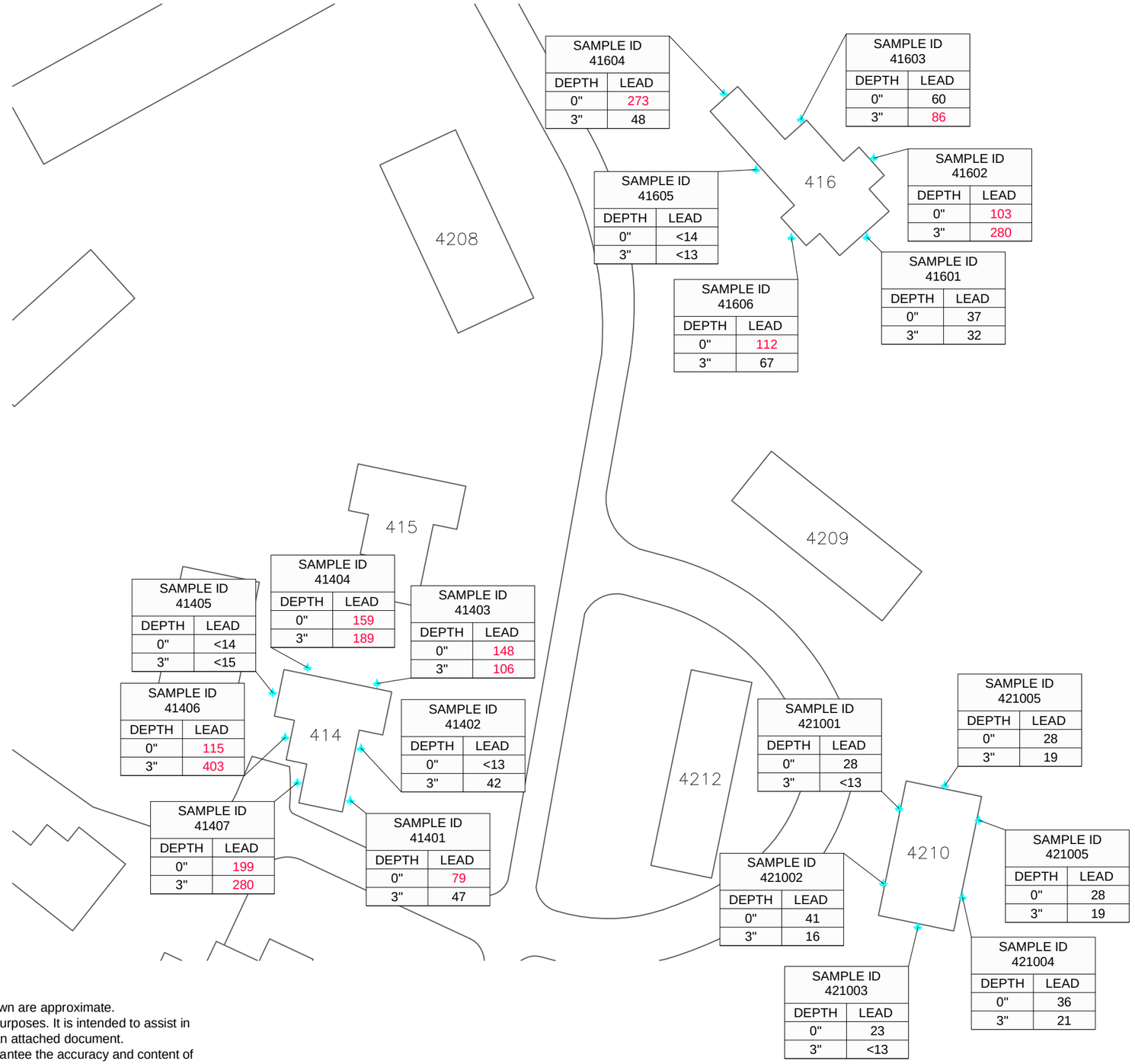
Building #421 Sample Locations
Decision Unit 3

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 9

\\pdx\projects\0\0758145\00\Cad\As-Builts\075814500_As Built.dwg, 09-14-10, 3:37pm, jesmith, 300



LEGEND:

Sample Location FWS

All lead concentrations reported in milligrams per kilogram (mg/kg).

Red indicates levels detected above the preliminary cleanup goal of 75 mg/kg.

N W E S

60 0 60
Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

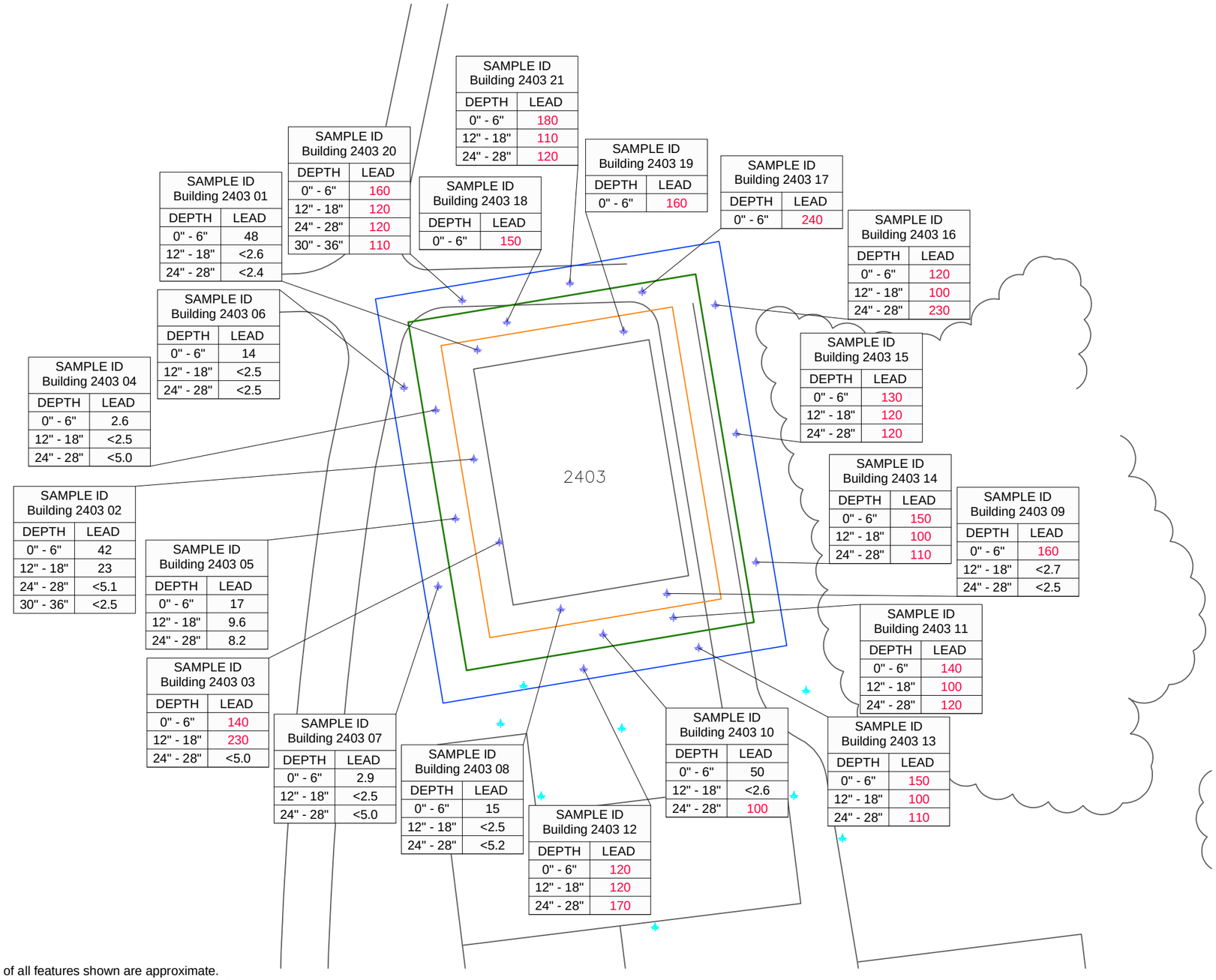
Buildings #414, 416, & 4210 Sample Locations
Decision Unit 3

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 10

\\pdx\projects\0\0758145\00\Cad\As-Builts\075814500_As Built.dwg, 09-14-10, 3:38pm, jesmith, 300



SAMPLE ID Building 2403 21

DEPTH	LEAD
0" - 6"	180
12" - 18"	110
24" - 28"	120

SAMPLE ID Building 2403 20

DEPTH	LEAD
0" - 6"	160
12" - 18"	120
24" - 28"	120
30" - 36"	110

SAMPLE ID Building 2403 19

DEPTH	LEAD
0" - 6"	160

SAMPLE ID Building 2403 18

DEPTH	LEAD
0" - 6"	150

SAMPLE ID Building 2403 17

DEPTH	LEAD
0" - 6"	240

SAMPLE ID Building 2403 16

DEPTH	LEAD
0" - 6"	120
12" - 18"	100
24" - 28"	230

SAMPLE ID Building 2403 01

DEPTH	LEAD
0" - 6"	48
12" - 18"	<2.6
24" - 28"	<2.4

SAMPLE ID Building 2403 06

DEPTH	LEAD
0" - 6"	14
12" - 18"	<2.5
24" - 28"	<2.5

SAMPLE ID Building 2403 04

DEPTH	LEAD
0" - 6"	2.6
12" - 18"	<2.5
24" - 28"	<5.0

SAMPLE ID Building 2403 15

DEPTH	LEAD
0" - 6"	130
12" - 18"	120
24" - 28"	120

SAMPLE ID Building 2403 14

DEPTH	LEAD
0" - 6"	150
12" - 18"	100
24" - 28"	110

SAMPLE ID Building 2403 09

DEPTH	LEAD
0" - 6"	160
12" - 18"	<2.7
24" - 28"	<2.5

SAMPLE ID Building 2403 02

DEPTH	LEAD
0" - 6"	42
12" - 18"	23
24" - 28"	<5.1
30" - 36"	<2.5

SAMPLE ID Building 2403 05

DEPTH	LEAD
0" - 6"	17
12" - 18"	9.6
24" - 28"	8.2

SAMPLE ID Building 2403 11

DEPTH	LEAD
0" - 6"	140
12" - 18"	100
24" - 28"	120

SAMPLE ID Building 2403 03

DEPTH	LEAD
0" - 6"	140
12" - 18"	230
24" - 28"	<5.0

SAMPLE ID Building 2403 07

DEPTH	LEAD
0" - 6"	2.9
12" - 18"	<2.5
24" - 28"	<5.0

SAMPLE ID Building 2403 08

DEPTH	LEAD
0" - 6"	15
12" - 18"	<2.5
24" - 28"	<5.2

SAMPLE ID Building 2403 10

DEPTH	LEAD
0" - 6"	50
12" - 18"	<2.6
24" - 28"	100

SAMPLE ID Building 2403 13

DEPTH	LEAD
0" - 6"	150
12" - 18"	100
24" - 28"	110

SAMPLE ID Building 2403 12

DEPTH	LEAD
0" - 6"	120
12" - 18"	120
24" - 28"	170

LEGEND:

- 15' sampling area
- 30' sampling area
- 45' sampling area
- Sample Location GeoEngineers
- Sample Location FWS

For lead data in FWS samples see Figure 12.

All lead concentrations reported in milligrams per kilogram (mg/kg).

Red indicates levels detected above the preliminary cleanup goal of 75 mg/kg.

N W E S

60 0 60
Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

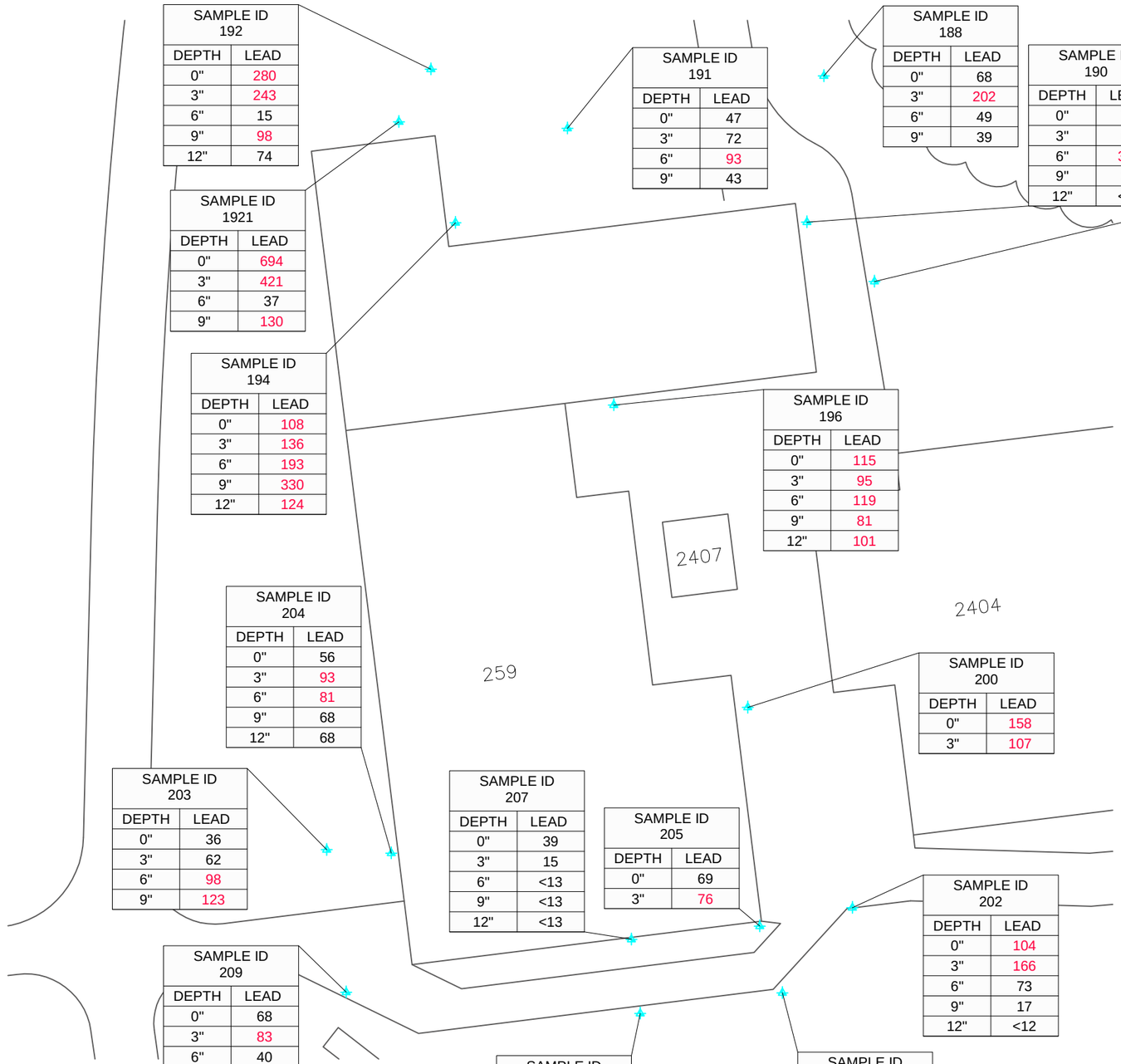
Building #2403 Sample Locations
Decision Unit 4

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 11

\\pdx\projects\0\0758145\00\Cad\As-Builts\0758145 00_As Built.dwg, 09-14-10, 3:38pm, jesmith, 300



SAMPLE ID 192	
DEPTH	LEAD
0"	280
3"	243
6"	15
9"	98
12"	74

SAMPLE ID 191	
DEPTH	LEAD
0"	47
3"	72
6"	93
9"	43

SAMPLE ID 188	
DEPTH	LEAD
0"	68
3"	202
6"	49
9"	39

SAMPLE ID 190	
DEPTH	LEAD
0"	74
3"	69
6"	354
9"	34
12"	<13

SAMPLE ID 1921	
DEPTH	LEAD
0"	694
3"	421
6"	37
9"	130

SAMPLE ID 193	
DEPTH	LEAD
0"	126
3"	143
6"	169
9"	58
12"	56

SAMPLE ID 194	
DEPTH	LEAD
0"	108
3"	136
6"	193
9"	330
12"	124

SAMPLE ID 196	
DEPTH	LEAD
0"	115
3"	95
6"	119
9"	81
12"	101

SAMPLE ID 204	
DEPTH	LEAD
0"	56
3"	93
6"	81
9"	68
12"	68

SAMPLE ID 200	
DEPTH	LEAD
0"	158
3"	107

SAMPLE ID 203	
DEPTH	LEAD
0"	36
3"	62
6"	98
9"	123

SAMPLE ID 207	
DEPTH	LEAD
0"	39
3"	15
6"	<13
9"	<13
12"	<13

SAMPLE ID 205	
DEPTH	LEAD
0"	69
3"	76

SAMPLE ID 202	
DEPTH	LEAD
0"	104
3"	166
6"	73
9"	17
12"	<12

SAMPLE ID 209	
DEPTH	LEAD
0"	68
3"	83
6"	40
9"	15
12"	<13

SAMPLE ID 208	
DEPTH	LEAD
0"	68
3"	74
6"	70
9"	22

SAMPLE ID 206	
DEPTH	LEAD
0"	23
3"	51
6"	25
9"	14

LEGEND:

Sample Location FWS

All lead concentrations reported in milligrams per kilogram (mg/kg).

Red indicates levels detected above the preliminary cleanup goal of 75 mg/kg.

N W E S

60 0 60
Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

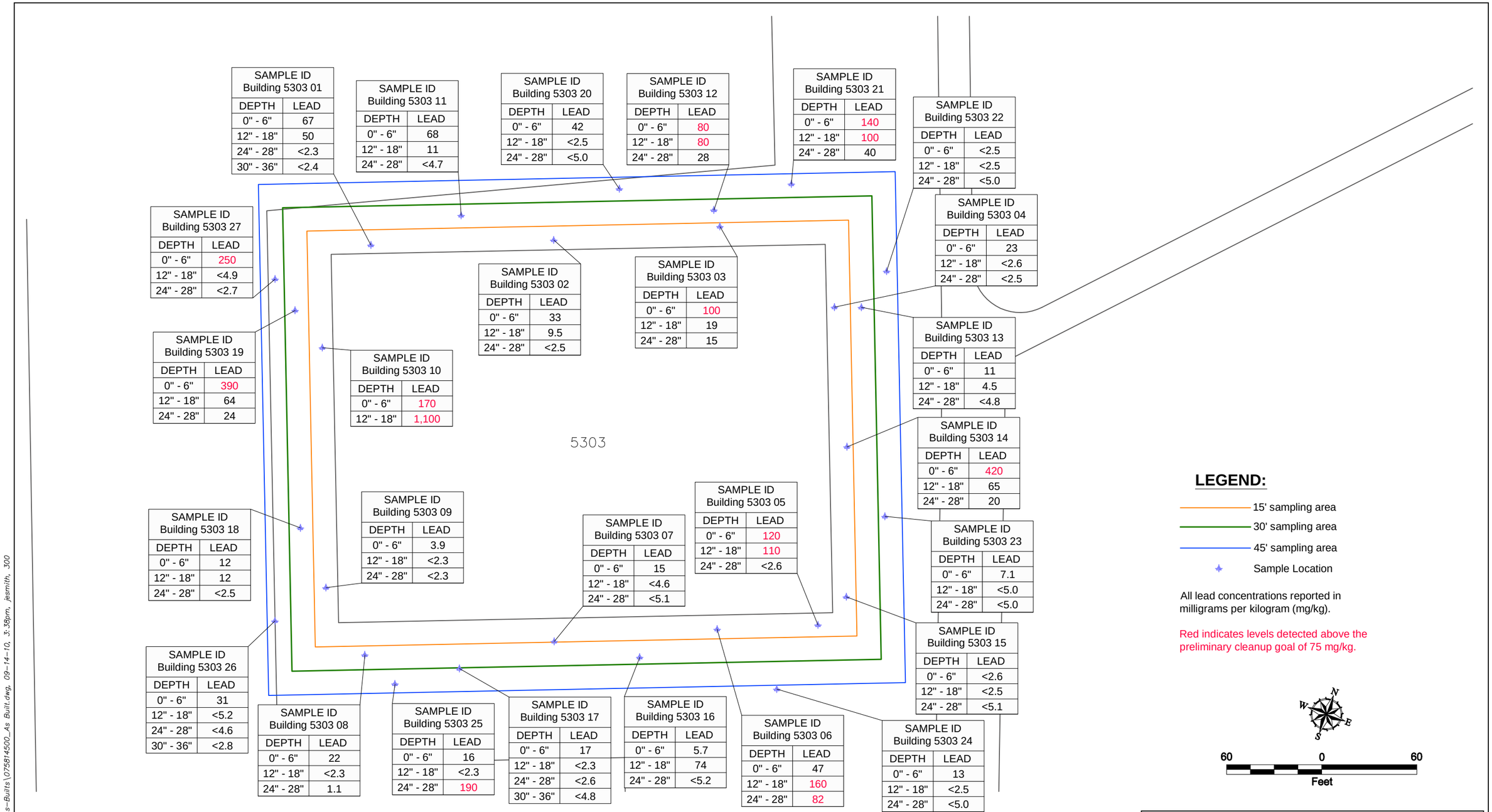
Building #259 Sample Locations
Decision Unit 4

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 12

\\pdx\projects\0\0758145\00\Cad\As-Builts\075814500_As Built.dwg, 09-14-10, 3:38pm, jesmith, 300



Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

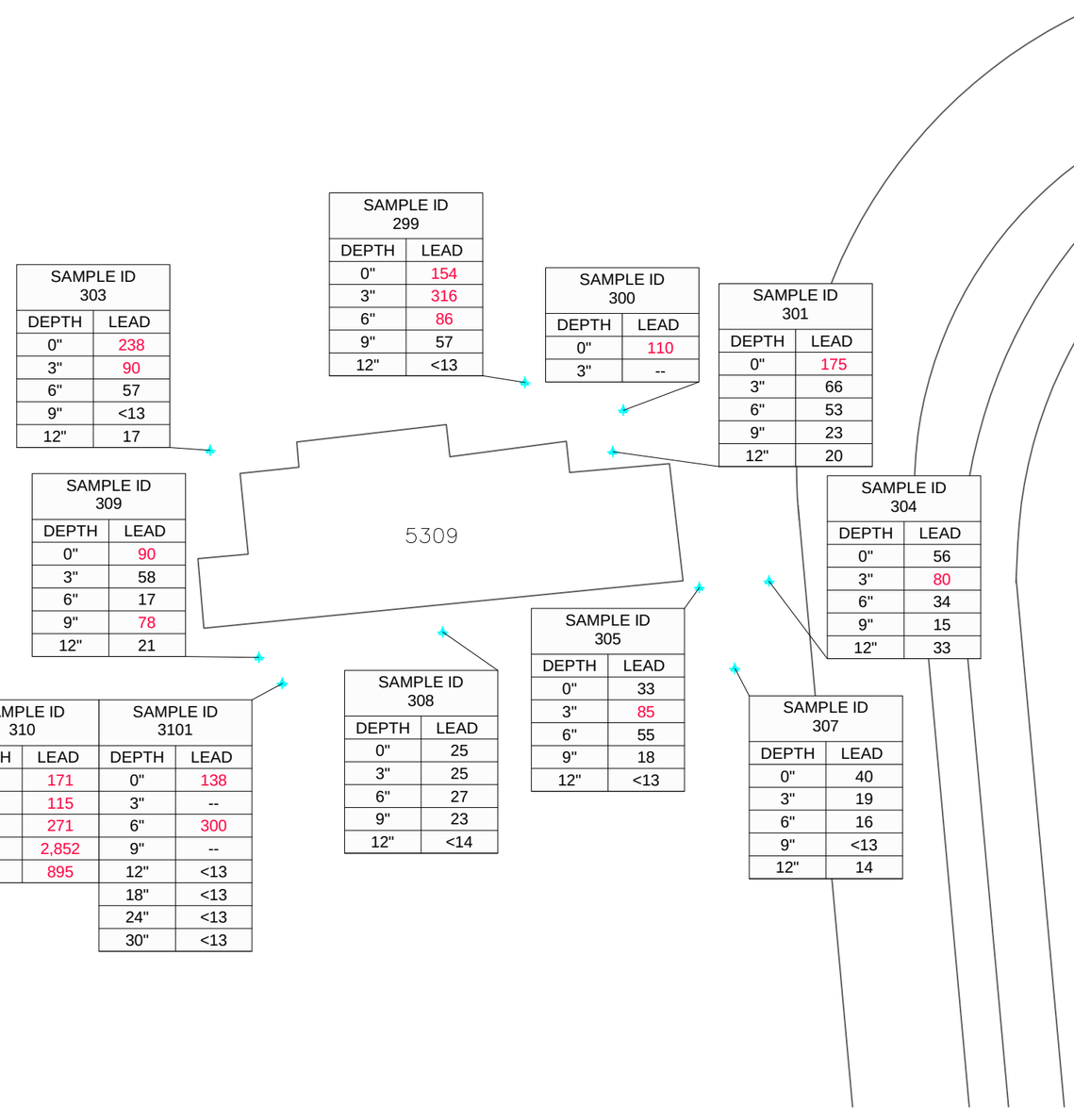
Building #5303 Sample Locations
Decision Unit 5

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 13

\\pdx\projects\0\0758145\00\Cad\As-Builts\075814500_As Built.dwg, 09-14-10, 3:38pm, jesmith, 300



SAMPLE ID 303	
DEPTH	LEAD
0"	238
3"	90
6"	57
9"	<13
12"	17

SAMPLE ID 299	
DEPTH	LEAD
0"	154
3"	316
6"	86
9"	57
12"	<13

SAMPLE ID 300	
DEPTH	LEAD
0"	110
3"	--

SAMPLE ID 301	
DEPTH	LEAD
0"	175
3"	66
6"	53
9"	23
12"	20

SAMPLE ID 309	
DEPTH	LEAD
0"	90
3"	58
6"	17
9"	78
12"	21

SAMPLE ID 304	
DEPTH	LEAD
0"	56
3"	80
6"	34
9"	15
12"	33

SAMPLE ID 305	
DEPTH	LEAD
0"	33
3"	85
6"	55
9"	18
12"	<13

SAMPLE ID 308	
DEPTH	LEAD
0"	25
3"	25
6"	27
9"	23
12"	<14

SAMPLE ID 310	
DEPTH	LEAD
0"	171
3"	115
6"	271
9"	2,852
12"	895

SAMPLE ID 3101	
DEPTH	LEAD
0"	138
3"	--
6"	300
9"	--
12"	<13
18"	<13
24"	<13
30"	<13

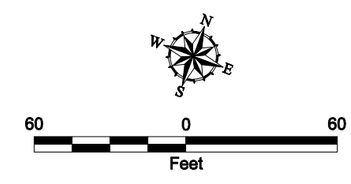
SAMPLE ID 307	
DEPTH	LEAD
0"	40
3"	19
6"	16
9"	<13
12"	14

LEGEND:

Sample Location FWS

All lead concentrations reported in milligrams per kilogram (mg/kg).

Red indicates levels detected above the preliminary cleanup goal of 75 mg/kg.



Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

Building #5309 Sample Locations
Decision Unit 5

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 14

\\pdx\projects\0\0758145\00\Cad\As-Builts\075814500_As Built.dwg, 09-14-10, 3:39pm, jesmith, 300

SAMPLE ID Building 363 01	
DEPTH	LEAD
0" - 6"	1,000
12" - 18"	60
24" - 28"	30

SAMPLE ID Building 363 06	
DEPTH	LEAD
0" - 6"	85
12" - 18"	43
24" - 28"	16

SAMPLE ID Building 363 07	
DEPTH	LEAD
0" - 6"	110
12" - 18"	38
24" - 28"	<2.7
30" - 36"	110

SAMPLE ID Building 363 08	
DEPTH	LEAD
0" - 6"	610

SAMPLE ID Building 363 09	
DEPTH	LEAD
0" - 6"	370

SAMPLE ID Building 363 12	
DEPTH	LEAD
0" - 6"	9,300
12" - 18"	130
24" - 28"	120

SAMPLE ID Building 363 11	
DEPTH	LEAD
0" - 6"	180
12" - 18"	130
24" - 28"	160

SAMPLE ID Building 363 02	
DEPTH	LEAD
0" - 6"	130
12" - 18"	23
24" - 28"	46

SAMPLE ID Building 363 16	
DEPTH	LEAD
0" - 6"	330
12" - 18"	160
24" - 28"	120

SAMPLE ID Building 363 03	
DEPTH	LEAD
0" - 6"	83
12" - 18"	63
24" - 28"	79
30" - 36"	17

SAMPLE ID Building 363 13	
DEPTH	LEAD
0" - 6"	240
12" - 18"	120
24" - 28"	110

SAMPLE ID Building 363 10	
DEPTH	LEAD
0" - 6"	210

SAMPLE ID Building 363 15	
DEPTH	LEAD
0" - 6"	560
12" - 18"	220

SAMPLE ID Building 363 05	
DEPTH	LEAD
0" - 6"	430
12" - 18"	180
24" - 28"	260

SAMPLE ID Building 363 14	
DEPTH	LEAD
0" - 6"	260
12" - 18"	160
24" - 28"	150

SAMPLE ID Building 363 04	
DEPTH	LEAD
0" - 6"	980
12" - 18"	490
24" - 28"	180

LEGEND:

- 15' sampling area
- 30' sampling area
- 45' sampling area
- Sample Location GeoEngineers
- Sample Location FWS

For lead data in FWS samples see Figure 16.

All lead concentrations reported in milligrams per kilogram (mg/kg).

Red indicates levels detected above the preliminary cleanup goal of 75 mg/kg.

N W E S

60 0 60
Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

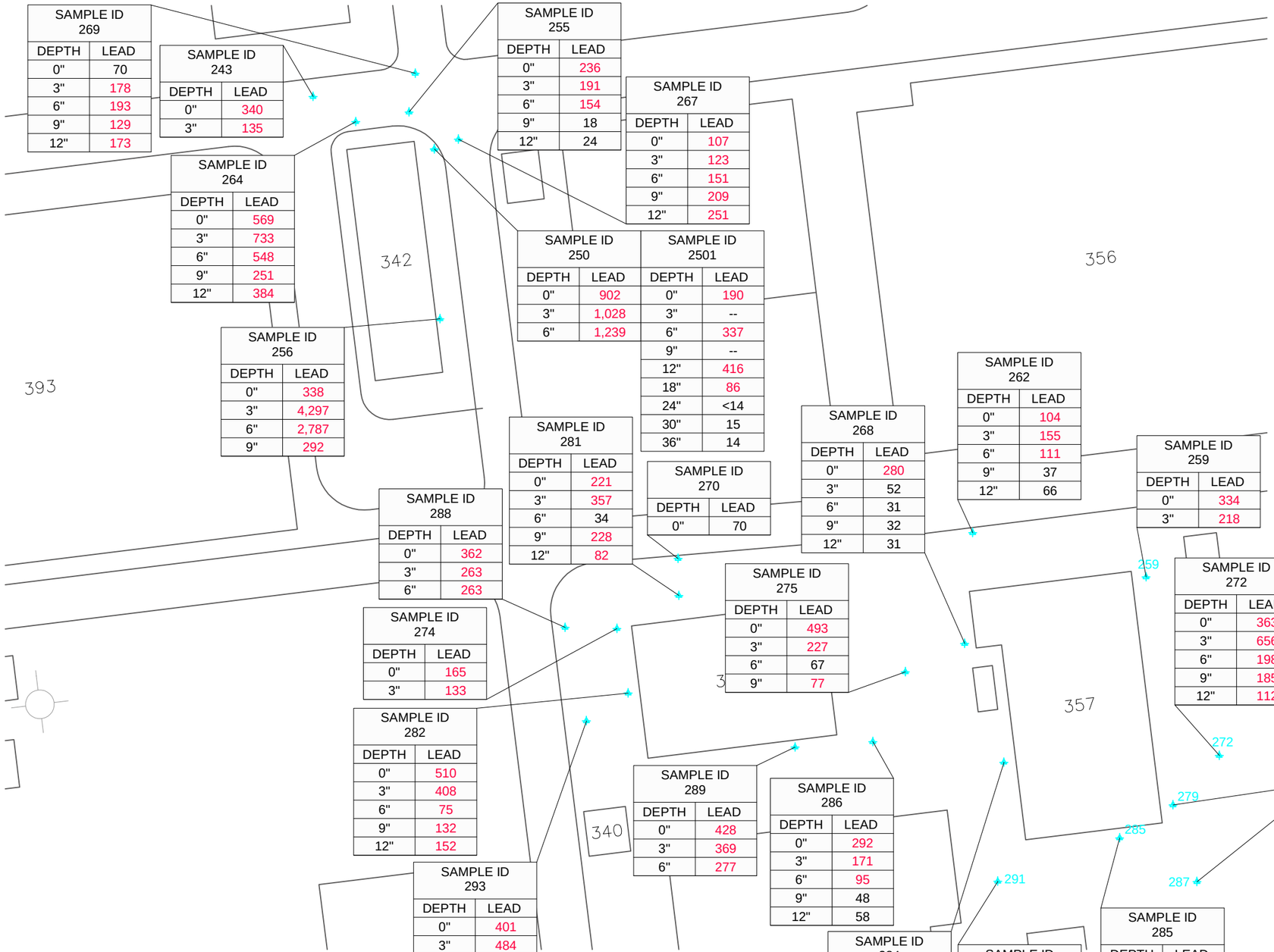
Building #363 Sample Locations
Decision Unit 6

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 15

\\pdx\projects\0\0758145\00\Cad\As-Builts\075814500_As Built.dwg, 09-14-10, 3:39pm, jasmith, 300



SAMPLE ID 269	
DEPTH	LEAD
0"	70
3"	178
6"	193
9"	129
12"	173

SAMPLE ID 243	
DEPTH	LEAD
0"	340
3"	135

SAMPLE ID 255	
DEPTH	LEAD
0"	236
3"	191
6"	154
9"	18
12"	24

SAMPLE ID 267	
DEPTH	LEAD
0"	107
3"	123
6"	151
9"	209
12"	251

SAMPLE ID 264	
DEPTH	LEAD
0"	569
3"	733
6"	548
9"	251
12"	384

SAMPLE ID 250	
DEPTH	LEAD
0"	902
3"	1,028
6"	1,239

SAMPLE ID 2501	
DEPTH	LEAD
0"	190
3"	--
6"	337
9"	--
12"	416
18"	86
24"	<14
30"	15
36"	14

SAMPLE ID 256	
DEPTH	LEAD
0"	338
3"	4,297
6"	2,787
9"	292

SAMPLE ID 262	
DEPTH	LEAD
0"	104
3"	155
6"	111
9"	37
12"	66

SAMPLE ID 281	
DEPTH	LEAD
0"	221
3"	357
6"	34
9"	228
12"	82

SAMPLE ID 268	
DEPTH	LEAD
0"	280
3"	52
6"	31
9"	32
12"	31

SAMPLE ID 270	
DEPTH	LEAD
0"	70

SAMPLE ID 259	
DEPTH	LEAD
0"	334
3"	218

SAMPLE ID 288	
DEPTH	LEAD
0"	362
3"	263
6"	263

SAMPLE ID 275	
DEPTH	LEAD
0"	493
3"	227
6"	67
9"	77

SAMPLE ID 272	
DEPTH	LEAD
0"	363
3"	656
6"	198
9"	185
12"	112

SAMPLE ID 274	
DEPTH	LEAD
0"	165
3"	133

SAMPLE ID 279	
DEPTH	LEAD
0"	471
3"	255
6"	350
9"	162
12"	50

SAMPLE ID 282	
DEPTH	LEAD
0"	510
3"	408
6"	75
9"	132
12"	152

SAMPLE ID 289	
DEPTH	LEAD
0"	428
3"	369
6"	277

SAMPLE ID 286	
DEPTH	LEAD
0"	292
3"	171
6"	95
9"	48
12"	58

SAMPLE ID 287	
DEPTH	LEAD
0"	142
3"	58
6"	177
9"	143
12"	131

SAMPLE ID 293	
DEPTH	LEAD
0"	401
3"	484
6"	1167
9"	291
12"	69

SAMPLE ID 284	
DEPTH	LEAD
0"	700
3"	772
6"	472
9"	283
12"	99

SAMPLE ID 291	
DEPTH	LEAD
0"	71
3"	41
6"	62
9"	59
12"	29

SAMPLE ID 285	
DEPTH	LEAD
0"	440
3"	49

N
W
E
S

60 0 60
Feet

LEGEND:

Sample Location FWS

All lead concentrations reported in milligrams per kilogram (mg/kg).

Red indicates levels detected above the preliminary cleanup goal of 75 mg/kg.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

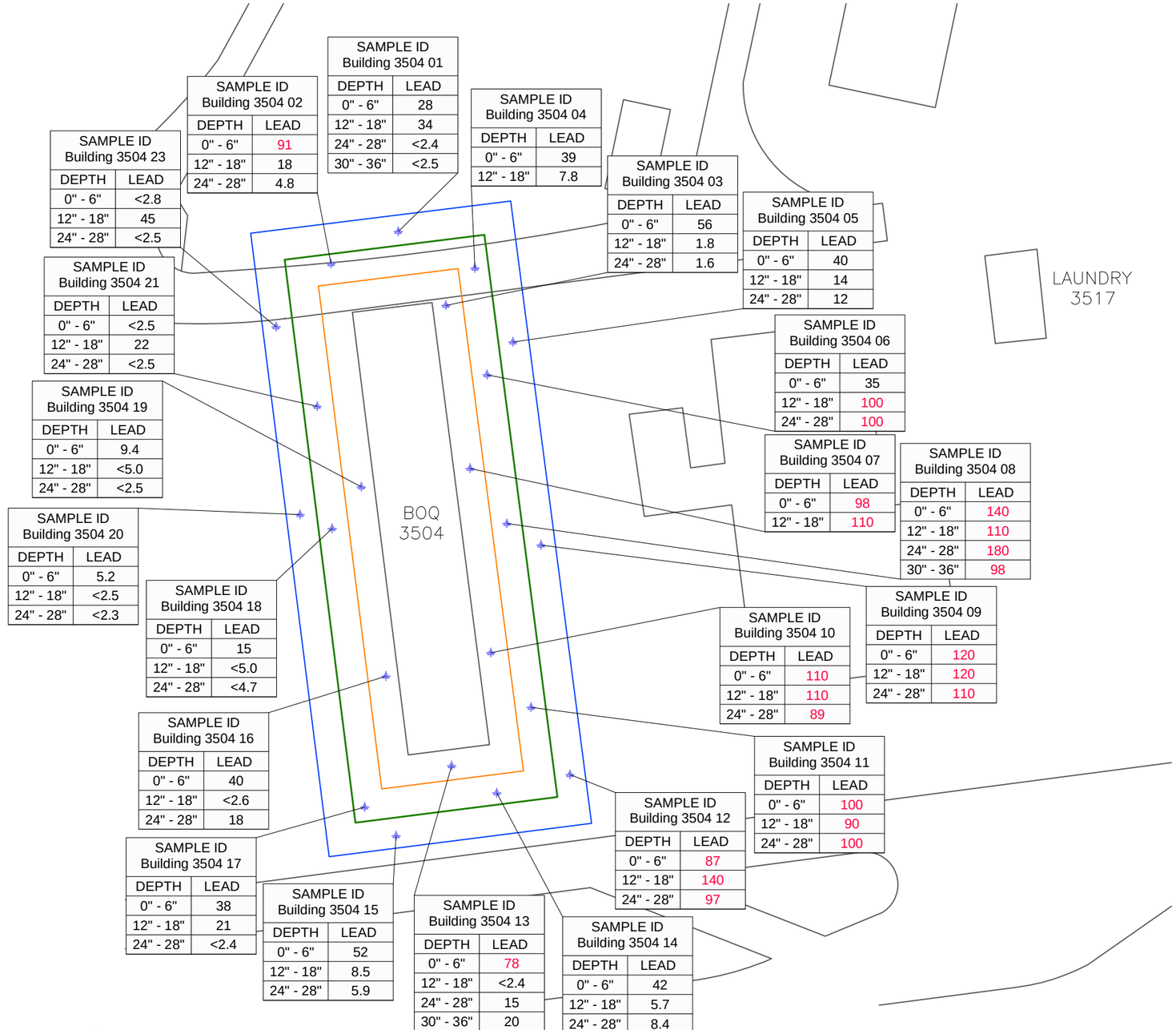
Building #342, 353, & 357 Sample Locations
Decision Unit 6

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 16

\\pdx\projects\0\0758145\00\Cad\As-Builts\075814500_As Built.dwg, 09-14-10, 3:40pm, jesmith, 300



SAMPLE ID Building 3504 01

DEPTH	LEAD
0" - 6"	28
12" - 18"	34
24" - 28"	<2.4
30" - 36"	<2.5

SAMPLE ID Building 3504 02

DEPTH	LEAD
0" - 6"	91
12" - 18"	18
24" - 28"	4.8

SAMPLE ID Building 3504 03

DEPTH	LEAD
0" - 6"	56
12" - 18"	1.8
24" - 28"	1.6

SAMPLE ID Building 3504 04

DEPTH	LEAD
0" - 6"	39
12" - 18"	7.8

SAMPLE ID Building 3504 05

DEPTH	LEAD
0" - 6"	40
12" - 18"	14
24" - 28"	12

SAMPLE ID Building 3504 06

DEPTH	LEAD
0" - 6"	35
12" - 18"	100
24" - 28"	100

SAMPLE ID Building 3504 07

DEPTH	LEAD
0" - 6"	98
12" - 18"	110

SAMPLE ID Building 3504 08

DEPTH	LEAD
0" - 6"	140
12" - 18"	110
24" - 28"	180
30" - 36"	98

SAMPLE ID Building 3504 09

DEPTH	LEAD
0" - 6"	120
12" - 18"	120
24" - 28"	110

SAMPLE ID Building 3504 10

DEPTH	LEAD
0" - 6"	110
12" - 18"	110
24" - 28"	89

SAMPLE ID Building 3504 11

DEPTH	LEAD
0" - 6"	100
12" - 18"	90
24" - 28"	100

SAMPLE ID Building 3504 12

DEPTH	LEAD
0" - 6"	87
12" - 18"	140
24" - 28"	97

SAMPLE ID Building 3504 13

DEPTH	LEAD
0" - 6"	78
12" - 18"	<2.4
24" - 28"	15
30" - 36"	20

SAMPLE ID Building 3504 14

DEPTH	LEAD
0" - 6"	42
12" - 18"	5.7
24" - 28"	8.4

SAMPLE ID Building 3504 15

DEPTH	LEAD
0" - 6"	52
12" - 18"	8.5
24" - 28"	5.9

SAMPLE ID Building 3504 16

DEPTH	LEAD
0" - 6"	40
12" - 18"	<2.6
24" - 28"	18

SAMPLE ID Building 3504 17

DEPTH	LEAD
0" - 6"	38
12" - 18"	21
24" - 28"	<2.4

SAMPLE ID Building 3504 18

DEPTH	LEAD
0" - 6"	15
12" - 18"	<5.0
24" - 28"	<4.7

SAMPLE ID Building 3504 19

DEPTH	LEAD
0" - 6"	9.4
12" - 18"	<5.0
24" - 28"	<2.5

SAMPLE ID Building 3504 20

DEPTH	LEAD
0" - 6"	5.2
12" - 18"	<2.5
24" - 28"	<2.3

SAMPLE ID Building 3504 21

DEPTH	LEAD
0" - 6"	<2.5
12" - 18"	22
24" - 28"	<2.5

SAMPLE ID Building 3504 23

DEPTH	LEAD
0" - 6"	<2.8
12" - 18"	45
24" - 28"	<2.5

LEGEND:

- 15' sampling area
- 30' sampling area
- 45' sampling area
- Sample Location GeoEngineers

All lead concentrations reported in milligrams per kilogram (mg/kg).

Red indicates levels detected above the preliminary cleanup goal of 75 mg/kg.

N W E S

60 0 60
Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

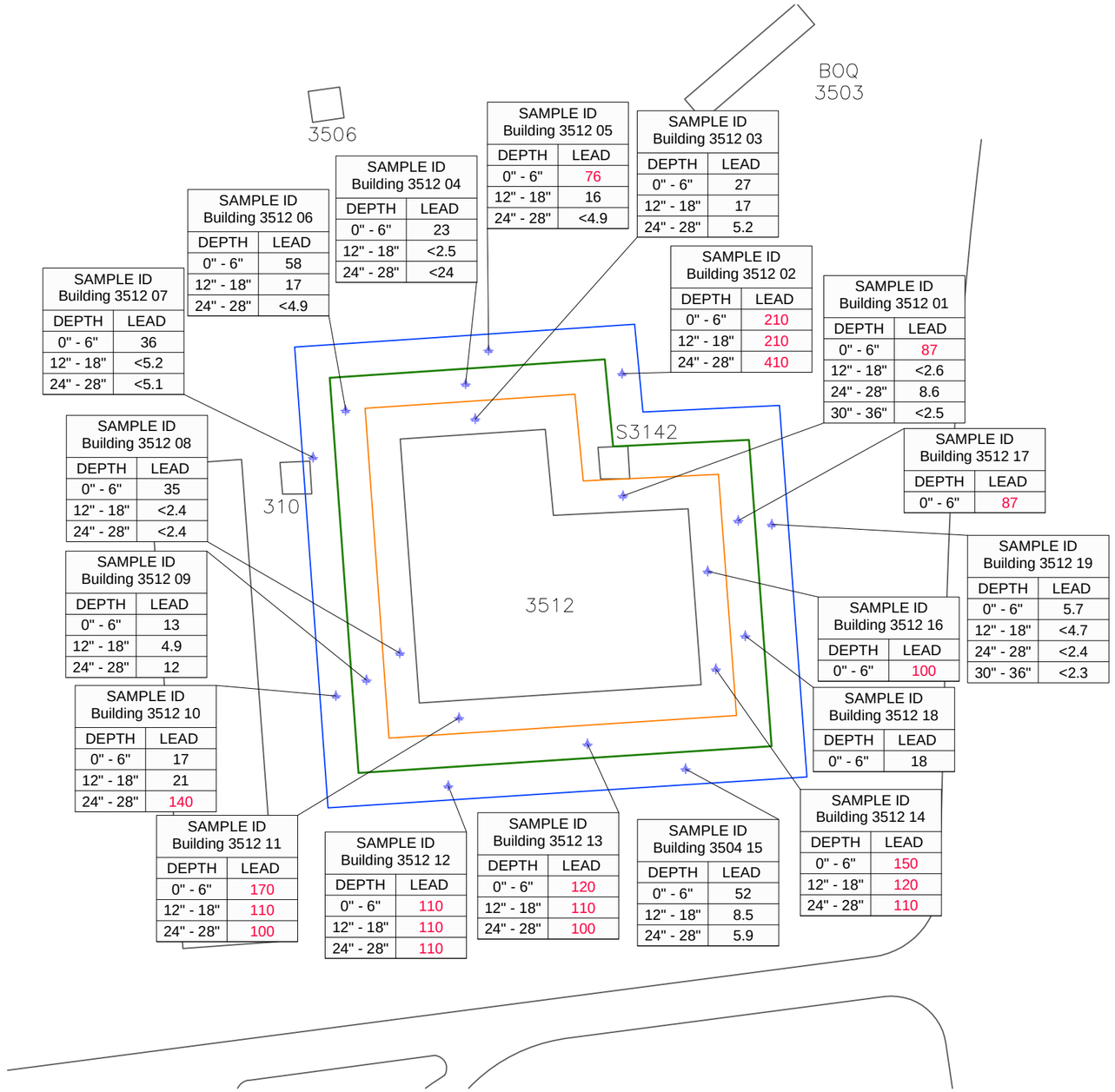
Building #3504 Sample Locations
Decision Unit 7

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 17

\\pdx\projects\0\0758145\00\Cad\As-Builts\075814500_As Built.dwg, 09-14-10, 3:40pm, jesmith, 300



SAMPLE ID Building 3512 01	
DEPTH	LEAD
0" - 6"	87
12" - 18"	<2.6
24" - 28"	8.6
30" - 36"	<2.5

SAMPLE ID Building 3512 02	
DEPTH	LEAD
0" - 6"	210
12" - 18"	210
24" - 28"	410

SAMPLE ID Building 3512 03	
DEPTH	LEAD
0" - 6"	27
12" - 18"	17
24" - 28"	5.2

SAMPLE ID Building 3512 04	
DEPTH	LEAD
0" - 6"	23
12" - 18"	<2.5
24" - 28"	<24

SAMPLE ID Building 3512 05	
DEPTH	LEAD
0" - 6"	76
12" - 18"	16
24" - 28"	<4.9

SAMPLE ID Building 3512 06	
DEPTH	LEAD
0" - 6"	58
12" - 18"	17
24" - 28"	<4.9

SAMPLE ID Building 3512 07	
DEPTH	LEAD
0" - 6"	36
12" - 18"	<5.2
24" - 28"	<5.1

SAMPLE ID Building 3512 08	
DEPTH	LEAD
0" - 6"	35
12" - 18"	<2.4
24" - 28"	<2.4

SAMPLE ID Building 3512 09	
DEPTH	LEAD
0" - 6"	13
12" - 18"	4.9
24" - 28"	12

SAMPLE ID Building 3512 10	
DEPTH	LEAD
0" - 6"	17
12" - 18"	21
24" - 28"	140

SAMPLE ID Building 3512 11	
DEPTH	LEAD
0" - 6"	170
12" - 18"	110
24" - 28"	100

SAMPLE ID Building 3512 12	
DEPTH	LEAD
0" - 6"	110
12" - 18"	110
24" - 28"	110

SAMPLE ID Building 3512 13	
DEPTH	LEAD
0" - 6"	120
12" - 18"	110
24" - 28"	100

SAMPLE ID Building 3504 15	
DEPTH	LEAD
0" - 6"	52
12" - 18"	8.5
24" - 28"	5.9

SAMPLE ID Building 3512 14	
DEPTH	LEAD
0" - 6"	150
12" - 18"	120
24" - 28"	110

SAMPLE ID Building 3512 18	
DEPTH	LEAD
0" - 6"	18

SAMPLE ID Building 3512 16	
DEPTH	LEAD
0" - 6"	100

SAMPLE ID Building 3512 17	
DEPTH	LEAD
0" - 6"	87

SAMPLE ID Building 3512 19	
DEPTH	LEAD
0" - 6"	5.7
12" - 18"	<4.7
24" - 28"	<2.4
30" - 36"	<2.3

LEGEND:

- 15' sampling area
- 30' sampling area
- 45' sampling area
- Sample Location GeoEngineers

All lead concentrations reported in milligrams per kilogram (mg/kg).

Red indicates levels detected above the preliminary cleanup goal of 75 mg/kg.

60 0 60
Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

Building #3512 Sample Locations
Decision Unit 7

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 18

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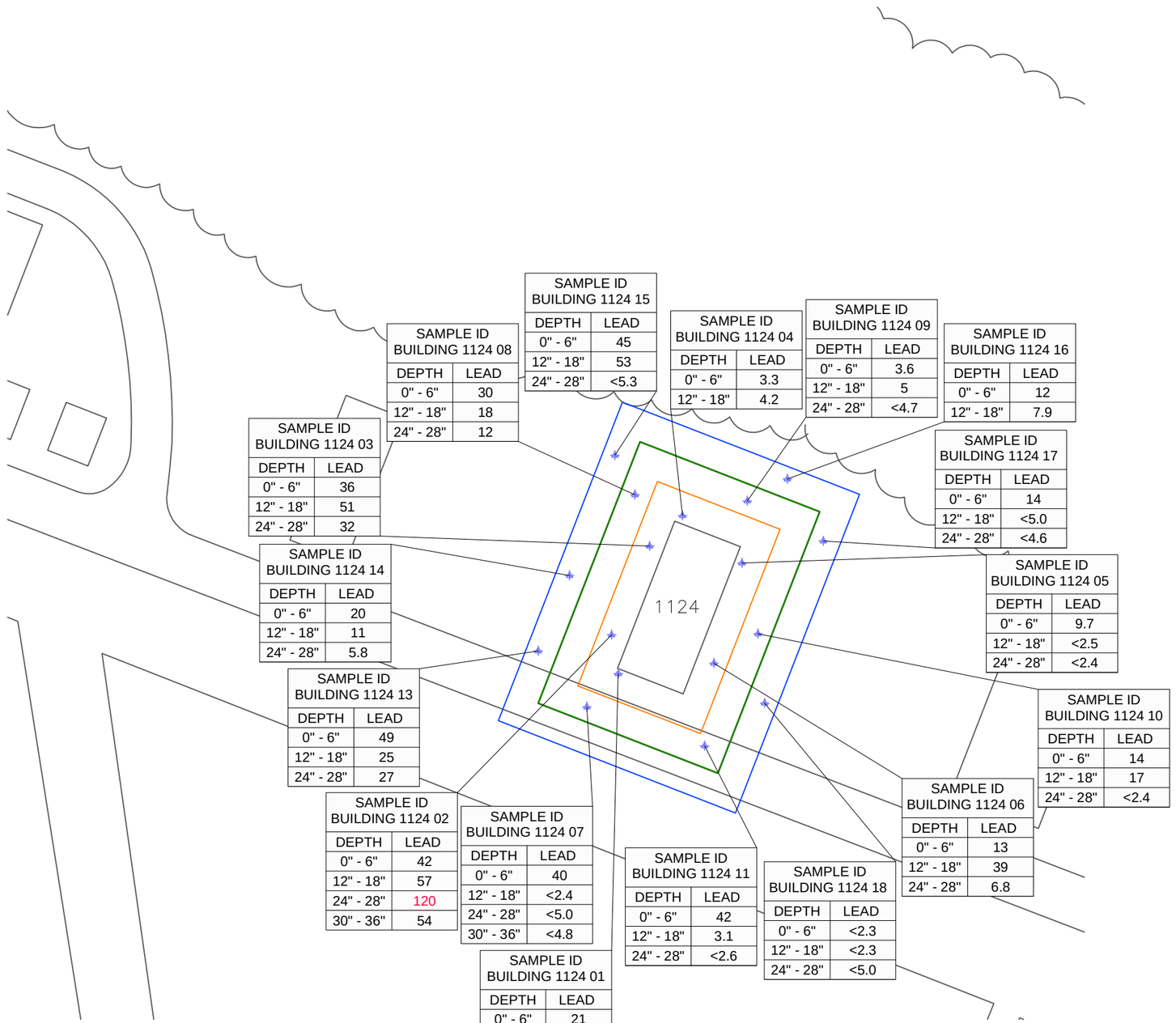

SAMPLE ID BUILDING 1124 15

DEPTH	LEAD
0" - 6"	45
12" - 18"	53
24" - 28"	<5.3

SAMPLE ID BUILDING 1124 08

DEPTH	LEAD
0" - 6"	30
12" - 18"	18
24" - 28"	12

SAMPLE ID BUILDING 1124 04

DEPTH	LEAD
0" - 6"	3.3
12" - 18"	4.2

SAMPLE ID BUILDING 1124 09

DEPTH	LEAD
0" - 6"	3.6
12" - 18"	5
24" - 28"	<4.7

SAMPLE ID BUILDING 1124 16

DEPTH	LEAD
0" - 6"	12
12" - 18"	7.9

SAMPLE ID BUILDING 1124 03

DEPTH	LEAD
0" - 6"	36
12" - 18"	51
24" - 28"	32

SAMPLE ID BUILDING 1124 17

DEPTH	LEAD
0" - 6"	14
12" - 18"	<5.0
24" - 28"	<4.6

SAMPLE ID BUILDING 1124 14

DEPTH	LEAD
0" - 6"	20
12" - 18"	11
24" - 28"	5.8

SAMPLE ID BUILDING 1124 05

DEPTH	LEAD
0" - 6"	9.7
12" - 18"	<2.5
24" - 28"	<2.4

SAMPLE ID BUILDING 1124 13

DEPTH	LEAD
0" - 6"	49
12" - 18"	25
24" - 28"	27

SAMPLE ID BUILDING 1124 10

DEPTH	LEAD
0" - 6"	14
12" - 18"	17
24" - 28"	<2.4

SAMPLE ID BUILDING 1124 06

DEPTH	LEAD
0" - 6"	13
12" - 18"	39
24" - 28"	6.8

SAMPLE ID BUILDING 1124 02

DEPTH	LEAD
0" - 6"	42
12" - 18"	57
24" - 28"	120
30" - 36"	54

SAMPLE ID BUILDING 1124 07

DEPTH	LEAD
0" - 6"	40
12" - 18"	<2.4
24" - 28"	<5.0
30" - 36"	<4.8

SAMPLE ID BUILDING 1124 11

DEPTH	LEAD
0" - 6"	42
12" - 18"	3.1
24" - 28"	<2.6

SAMPLE ID BUILDING 1124 18

DEPTH	LEAD
0" - 6"	<2.3
12" - 18"	<2.3
24" - 28"	<5.0

SAMPLE ID BUILDING 1124 01

DEPTH	LEAD
0" - 6"	21
12" - 18"	17
24" - 28"	<2.6

LEGEND:

- 15' sampling area
- 30' sampling area
- 45' sampling area
- Sample Location GeoEngineers

All lead concentrations reported in milligrams per kilogram (mg/kg).

Red indicates levels detected above the preliminary cleanup goal of 75 mg/kg.

N W E S

60 0 60
Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base drawing provided by Feraro Choi - Midway Site Plan 2003 and modified by GeoEngineers' field personnel.

Building #1124 Sample Locations
Decision Unit 9

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

GEOENGINEERS

Figure 19

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APPENDICES

GeoEngineers

APPENDIX A
Field Procedures

APPENDIX A
FIELD PROCEDURES

GENERAL

This appendix describes the field procedures, field quality assurance/quality control (QA/QC) protocol, and the chemical testing program implemented during site activities. The field activities included the following activities:

- Collection of soil samples with hand tools;
- Collection of soil samples with hand augers;
- Location control;
- Decontamination procedures; and
- Handling of investigation-derived waste (IDW).

Collection of Soil Samples Using Hand Tools

Soil samples were collected from near-surface depths using tools such as spades, shovels, trowels, and scoops. At each sample location, hand tools were used to remove surface soil until the desired sample depth interval was reached. At that depth, a sample was collected using a stainless steel scoop or plastic scoop. Representative soil samples were collected using this procedure with proper care. Chrome-plated tools were not used.

Discrete soil samples, were collected using a clean/decontaminated stainless-steel or plastic spoon. Composite soil samples were collected using a stainless-steel or plastic spoon, and transferred to a disposable plastic bowl. The samples were mixed in the bowl to make a single sample.

Sealed Whirl-Pak sample bags were placed in a 5-gallon bucket with a lid and delivered to the analytical laboratory within laboratory-specified holding times. Standard chain-of-custody procedures were observed during transport of the samples to the laboratory.

Collection of Soil Samples from Hand Augers

This sample collection system consists of an auger, a series of extensions, and a "T" handle. The auger was used to bore a hole to a desired sampling depth and then withdrawn. The sample was collected directly from the auger. The hand auger sampling procedure is summarized below:

- Attach the auger bit to a drill rod extension, and attach the "T" handle to the drill rod.
- Clear the area to be sampled of any surface debris (e.g., twigs, rocks, litter).
- Begin augering, periodically removing and depositing accumulated soils near the drill hole.
- After reaching the desired depth, the auger was removed from the hole. Collect the sample after the auger is removed from the hole.

- The samples were placed in a plastic, homogenization container, and mixed thoroughly to obtain a homogenous sample representative of the entire sampling interval. The mixed sample was then placed into appropriate, labeled Whirl-Pak. When another sample was collected in the same hole, but at a greater depth, the auger was reattached and advanced.
- All holes were abandoned by returning the removed soil to the open hole.
- Samples were placed in a 5-gallon bucket with a lid and delivered to the analytical laboratory within laboratory-specified holding times. Standard chain-of-custody procedures were observed during transport of the samples to the laboratory.

Location Control

GeoEngineers recorded the position of each exploration with a sub-meter grade GPS instrument and when necessary each point was measured to known locations.

Decontamination Procedures

The objective of the decontamination procedure was to minimize the potential for cross contamination between exploration locations and between individual samples within a specific exploration. Sampling equipment was decontaminated in accordance with the following procedures before each sampling attempt or measurement.

- Brush equipment with a wire brush, if necessary, to remove large particulate matter.
- Rinse with potable tap water.
- Wash with nonphosphate detergent solution (Liquinox and potable tap water).
- Rinse with potable tap water.

Handling of Investigation-Derived Waste

IDW anticipated to be generated during the project includes soil cuttings and decontamination water. Soil cuttings will be placed back in the exploration in the order removed. Purge water was disposed of in the sanitary sewer system. Disposable items, such as sample bags, gloves and protective overalls and paper towels, will be placed in plastic bags after use and deposited in trash receptacles for disposal.

APPENDIX B
Chemical Analytical Data and QA/QC Review

APPENDIX B
CHEMICAL ANALYTICAL DATA AND QA/QC REVIEW

Task-related data quality objectives (DQOs) varied according to the nature of the task. Data quality parameters for tasks requiring measurements were evaluated on precision, accuracy, representativeness, completeness, comparability and range. Data quality for field sampling methods were based on measurement quality criteria listed in the Work Plan, and were checked using analytical results of field duplicate samples. For chemical analyses, established precision and accuracy protocols, combined with those outlined in the Quality Assurance Project Plan (QAPP) (work plan) suffice for analytical data quality. The laboratory's QA manager was responsible for maintaining the method-defined and QAPP-defined quality assurance/quality control (QA/QC) criteria.

Samples

All samples obtained for chemical analysis were transferred into clean sample containers. Soil samples were collected in plastic Whirl-Pak® bags. Whirl-Pak® bags are equipped with a built-in wire for self-closing and they include a puncture-proof tab. The bags are also designed with a built in write-on strip for labeling purposes.

Sufficient sample volume was obtained for the laboratory to complete the method-specific quality control (QC) analyses. Possession of the samples was documented by the chain-of-custody. The chain-of-custody forms were signed and dated in the appropriate places by parties involved with a transfer of custody.

Each container was labeled by the field technician to avoid the possibility of misidentification. Each sample label contained the field sample identification, sample date and sample time.

Upon receipt at the analytical laboratory, each sample was logged into tracking system. Each sample was assigned a unique laboratory identification number used by the laboratory for analysis assignment, sample tracking and data reporting. Upon receipt of the samples at the laboratory, the following procedures were followed. The custody seals were broken, the chain-of-custody form was signed by the laboratory personnel, and the conditions of the samples were recorded on the form. The original chain-of-custody form remained with the laboratory and copies were returned to the relinquishing party.

FIELD QUALITY CONTROL

Field quality control measures included the collection of duplicate as well as documentation of field measurements and observations and field instrument calibration. The Work Plan detailed the use of field rinseate blanks. Due to a shipping error, the field containers and de-ionized (DI) water for the collection of the rinseate blanks was not delivered to the project site. A detailed discussion is listed below.

Field Duplicate Samples

Field duplicate samples were collected at a minimum frequency of 1 for every 20 samples (5 percent) per sampling event. In total 34 duplicates were collected during the field activities.

Duplicate samples were collected to assess matrix homogeneity, sampling procedures and laboratory analytical consistency. The field duplicates were analyzed by the same analytical methods used for primary samples. Relative percent differences (RPDs) for field duplicates were calculated to assess the data precision and accuracy and potential variability caused by sample handling. Table B-1 summarizes the RPDs for the field duplicate samples. The RPDs between the primary and field duplicate soil samples range from 4 percent to 167 percent, indicating that sample precision may be low. Elevated RPDs are not uncommon in soil samples due to the natural heterogeneity of soil. Field duplicate precision is normally considered acceptable when the RPD is less than 30 percent. While some of the RPDs were above these criteria, this is not unexpected because of the heterogeneity of the sandy soils.

Rinseate Blank Samples

The Work Plan called for the collection and analysis of one rinseate blank for per day. The use of rinseate blanks were intended to assess the effectiveness of equipment decontamination procedures. Due to a shipping error, the field containers and DI water for the collection of the rinseate blanks was not delivered to the project site.

The loss of the rinseate blank samples makes it difficult to evaluate the effectiveness of the field decontamination procedures. To the extent practical, disposable sampling equipment was used. This included disposable bowels, spoons, and gloves. When stainless steel equipment was used, (trowels and hand augers) the equipment was decontaminated per the Work Plan. The site soils were dry in nature with little organic matter. The lack of moisture and lack of organic material caused the site soils to not “stick” to the field sampling gear. In general, field staff had a difficult time in maintaining the soils within the hand auger. As such, it is unlikely that soils from previous sampling locations would stick to the augers, especially with the Liquinox and brush cleanings that were performed.

It is GeoEngineers opinion that the absence of the rinseate blank does not affect the usability of the data.

Trip Blank Samples

Sealed trip blank samples, consisting of carbon-free water, were obtained from the analytical laboratory and accompany each batch of samples from the site to the project laboratory. Trip blanks were not submitted for chemical analysis due to the non volatile nature of lead.

Documentation of Field Activities

Daily field activities, including observations, measurement data, and variations in field procedures were recorded on appropriate field forms. The original field forms are maintained in GeoEngineers' office files. Copies of the completed forms were maintained in a binder and sequentially numbered field file for reference during field activities. Indelible ink was used for all documentation. Photographic documentation of field activities was performed as appropriate.

LABORATORY QUALITY ASSURANCE

Analytical methods that were used for this project included:

- Total Lead by EPA Method 6010.
- Leachable concentrations of lead, in soil, using EPA Method 1311 (toxicity characteristic leaching procedure).
- Total lead using an x-ray florescence (XRF) instrument.

Laboratory Quality Control

The laboratory maintains an internal quality assurance program as documented in its laboratory quality assurance manual. The laboratory uses a combination of blanks, surrogate recoveries, duplicates, matrix spike recoveries, matrix spike duplicate recoveries, blank spike recoveries and blank spike duplicate recoveries to evaluate the analytical results. The laboratory also uses data quality goals for individual chemicals or groups of chemicals based on the long-term performance of the test methods. GeoEngineers reviewed each analytical data packet and completed a QA/QC checklist for each analytical data packet. Overall, the data was of usable quality and no quality control issues were identified.

TABLE B-1

SUMMARY OF RELATIVE PERCENT DIFFERENCES

FIELD DUPLICATE LEAD SOIL SAMPLES

MIDWAY ISLAND NATIONAL WILDLIFE REFUGE

MIDWAY ISLAND, HAWAII

Sample Identification	Lead (mg/kg)	Relative Percent Difference
BUILDING 363 01 12-18IN	**60**	33%
DUPLICATE 05 12-18IN	**43**	
BUILDING 363 02 12-18IN	**23**	-30%
DUPLICATE 06 12-18IN	**31**	
BUILDING 363 04 0-6IN	**980**	21%
DUPLICATE 07 0-6IN	**790**	
BUILDING 421 01 12-18IN	**28**	-40%
DUPLICATE 21 12-18IN	**42**	
BUILDING 421 05 0-6IN	**28**	-4%
DUPLICATE 22 0-6IN	**29**	
BUILDING 623 10 12-18IN	**170**	83%
DUPLICATE 23 12-18IN	**70**	
BUILDING 1124 04 0-6IN	**3.3**	-114%
DUPLICATE 09 0-6IN	**12**	
BUILDING 1124 07 0-6IN	**40**	-20%
DUPLICATE 10 0-6IN	**49**	
BUILDING 2403 01 0-6IN	**48**	-4%
DUPLICATE 26 0-6IN	50	
BUILDING 3504 01 0-6IN	**28**	15%
DUPLICATE 11 0-6IN	**24**	
BUILDING 3504 09 12-18IN	**120**	106%
DUPLICATE 12 12-18IN	**37**	
BUILDING 3512 01 24-28IN	**8.6**	41%
DUPLICATE 14 24-28IN	5.7	
BUILDING 4203 02 12-18IN	**120**	120%
DUPLICATE 29 12-18IN	**30**	
BUILDING 4210 11 0-6IN	**8.6**	-24%
DUPLICATE 32 0-6IN	**11**	
BUILDING 5303 07 0-6IN	**15**	-29%
DUPLICATE 03 0-6IN	**20**	
OPPORTUNISTIC 01 0-6IN	**4**	-167%
DUPLICATE 28 0-6IN	**44**	
OPPORTUNISTIC 13 0-6IN	**370**	35%
DUPLICATE 33 0-6IN	**260**	

Notes:

See Appendix C for discussion of relative percent differences (RPDs).

mg/kg = milligrams per kilogram

Target RPD is +/- 30%

RPD = Relaitve percent difference

APPENDIX C
Streamlined Risk Evaluation (SRE)

APPENDIX C
STREAMLINED RISK EVALUATION (SRE)

1.0 INTRODUCTION

This appendix presents the Streamlined Risk Evaluation (SRE), including the approach and assumptions that went into developing a recommended PCG for lead that is being used along with other parameters to come up with a remedy for lead in soil. The details of the removal action and associated costs are presented in the main text of this EE/CA.

Section 1.1 of this appendix discusses previous risk evaluations and toxicity studies completed at the Refuge and in particular Sand Island. Section 1.2 discusses the objectives of and need for conducting the SRE. Sections 2.0, 3.0 and 4.0 of this appendix discuss the conceptual site model (CSM), risk approach and lead cleanup value recommendations.

1.1. Background

The FWS and contractors have conducted a number of prior risk evaluations and toxicity studies at the site. This section presents a summary of these studies and the conclusions relevant to avian wildlife that utilize habitat at the site.

Ogden Environmental (Ogden, 1996), under contract to the FWS, conducted a Screening Ecological Risk Assessment (SERA) as part of the 1996 Site Investigation at Midway Island. Ogden evaluated surface soil, groundwater, surface water and sediment conditions at 36 terrestrial and marine study sites. Target receptors evaluated in the SERA include Laysan Albatross (*Phoebastria immutabilis*; ground nesting bird), Wedge-tailed Shearwater (*Puffinus pacificus; burrowing birds)*), Bonin Petrel (*Pterodroma hypoleuca*; burrowing birds), Golden Plover (*Pluvialus fulva*; Shorebirds), Green Sea Turtle (*Chelonia mydas*; endangered marine herbivore), Hawaiian Monk Seal (*Monachus schaunslandi*; endangered marine mammal), and marine aquatic invertebrates (prey base for higher trophic level receptors and indicators of sediment habitat quality). The SERA conclusions were as follows:

- A Baseline Ecological Risk Assessment (BERA) should be conducted and limited to the terrestrial environment at the Bulky Waste Landfill and the marine environment surrounding the Bulky Waste Landfill, the Runway Landfill and two Inner Harbor sites.
- The BERA should be limited to the following contaminants of potential ecological concern (CPECs): polychlorinated biphenyls (PCBs) and organochlorine pesticides at the four sites, and semivolatile organic compounds (SVOCs) in soil at the Bulky Waste Landfill.
- Target receptors considered in the BERA should be limited to burrowing birds (Wedge-tailed Shearwater and Bonin Petrel) for the terrestrial portion of the Bulky Waste Landfill. Ogden concluded that risks to ground nesting and shorebirds were minimal. Marine receptors considered in the BERA should include Green Sea Turtle, Hawaiian Monk Seal, and benthic infaunal and reef fish communities.

- The BERA should be limited to terrestrial exposure pathways (soil ingestion and dermal contact). Ogden concluded that potential risks from the inhalation exposure pathway were 3 to 6 orders of magnitude lower than those from ingestion and dermal contact.

Following the SERA, Ogden (1997) conducted a BERA as part of the 1996 Remedial Investigation (RI) at the site. The BERA focused on the concentration and distribution of PCBs and organochlorine pesticides at the four sites identified in the SERA. Subsurface soil data were obtained at the Bulky Waste Landfill to further evaluate the special status burrowing birds (Bonin Petrel was evaluated in the BERA to represent burrowing birds). Additional data were also obtained at the marine sites to evaluate the special status marine species (Green Sea Turtle and Hawaiian Monk Seal). Additional objectives of the BERA were to identify CPEC hot spots in the Bulky Waste Landfill and to improve estimates of exposure and risk.

GeoEngineers (2004), under contract with FWS, conducted a BERA at the February 2003 JP-5 Release Site. The 100,000-gallon JP-5 release took place at the Midway Island fuel storage facility, located at the Northeast corner of Sand Island. The primary objective of the BERA was to assess the potential for adverse impact to terrestrial species living in the vicinity of JP-5 fuel release. Terrestrial receptors evaluated were the Bonin Petrel and the Ironwood Tree. Contaminants evaluated in the BERA included petroleum-related compounds (JP-5, benzene, toluene, ethylbenzene, xylenes and polycyclic aromatic hydrocarbons [PAHs]) and PCBs (lead was not identified as a CPEC). The BERA concluded that contaminants associated with the 2003 JP-5 release posed negligible risks to the Bonin Petrel and iron wood trees.

FWS conducted an ecological risk assessment (ERA) in 2009 to evaluate lead in soil and the affects of lead on Laysan Albatross chicks (USFWS, 2009a). The primary source of lead in soil is the lead-based paint (LBP) used on the structures on Sand Island. Paint chips from those structures have high levels of lead and are present in the soil where the Laysan Albatross nests are located (USFWS, 2009a). The objectives of the FWS ERA were to characterize lead concentrations in soil around selected structures and lead concentrations in reference (background) areas and compare lead levels in soil to blood-lead levels in co-located Laysan Albatross chicks. The FWS concluded:

67 milligrams per kilogram (mg/kg) is representative of upper-end background concentration of lead in soil. Based on the findings of GeoEngineers 2010 investigation, the background concentration is between 5.7 and 9.4 mg/kg (see Section 3.2 of the EE/CA). The value of 67 mg/kg noted by the FWS is biased high.

- The concentration of lead in soil decreases with depth and distance from structures.
- Approximately 33 percent of the birds evaluated had blood-lead concentrations greater than the (10 micrograms per deciliter [µg/dL]), which was identified as being associated with the occurrence of sensitive clinical effects. As noted in Section 2.4.9.1 of the EE/CA, the threshold for sensitive effects according to Franson (1996) is 100 µg/dL.
- Soil lead concentrations less than 100 mg/kg will be protective of Laysan Albatross chicks (that is, those soil concentrations will not likely result in blood lead levels that exceed 10 µg/dL). Note that 20 µg/dL is used in this SRE as the blood lead level of concern (see Section 5 of the EE/CA for more details).

In summary, studies conducted by FWS and others at Sand Island between the late 1980s and 2009 have shown that Laysan Albatross nestlings (chicks) exhibited symptoms of lead toxicity and that their exposure is likely related to ingestion of LBP chips and soil contaminated with LBP chips, which the birds often pick up and place into their nests (USFWS, 2009a). The studies evaluating lead toxicity to the Laysan Albatross have identified lead-induced damages to the bird's peripheral nervous systems, leading to a syndrome known as "droopwing," where chicks are unable to retract their wings, which often drag on the ground (USFWS, 2009a).

1.2. Objectives and Need

Historical investigations at Midway indicate that the source of lead is lead-based paint (LBP) that was historically applied to buildings and other structures (USFWS, 2009a and Finkelstein et al., 2003). The LBP has weathered over time and subsequently migrated into the soil surrounding these buildings.

The specific objectives of this SRE are to:

- Assess whether lead in soil adjacent to buildings with LBP pose unacceptable risk to avian receptors that utilize habitat adjacent to these buildings;
- Develop a site-specific cleanup level for lead in soil that is protective of avian receptors that are present at the Refuge; and
- Use the PCG for lead (along with other parameters presented in the EE/CA) to select a response approach for lead in soil.

The SRE approach takes into consideration the toxicity of lead to avian receptors, including the routes of exposure and the ecology of avian wildlife at the Refuge. The SRE report also includes an evaluation of potential risks to avian receptors (Laysan Albatross, Bonin Petrel, and Laysan Duck) from exposure to lead contaminated soil and recommends a site-specific PCG for lead.

The FWS is currently undertaking the abatement of LBP from existing structures at the Refuge. However, this abatement process does not address LBP residues on or in the ground surrounding existing buildings. Site characterization conducted during implementation of the EE/CA work plan characterized the magnitude and extent of lead contamination around the existing structures at Sand Island. The site-specific soil PCG for lead (as discussed below) has been used to estimate the volume of lead contaminated soil that may need to be subject to the removal action.

2.0 CONCEPTUAL SITE MODEL (CSM)

The CSM introduces the framework for assessing receptors and routes of exposure that will be considered in the SRE. To be considered complete, an exposure pathway must have the following: an identified source of lead; a release or transport mechanism from the source; and an exposure route where contact to the receptor can occur.

Exposed receptors and routes of exposure are discussed in the context of "complete" or "incomplete" pathways. The CSM considers these pathways, as well as known and suspected sources of lead contamination, affected media, known and potential routes of migration, and the presence of known and potential avian receptors. Figure C-1 presents a graphical representation

of the CSM. More discussion on the CSM is provided subsequently in this section, including the mechanisms of lead toxicity in avian receptors, the life history of avian receptors at the Refuge and the sources of lead contamination.

2.1. Avian Toxicity to Lead

Numerous studies have documented lead as a cause of lethal and sublethal effects in birds (Eisler, 1988). The solubility of ingested lead in birds is increased by low stomach pH, which makes the lead more available for absorption into the blood stream. Observable signs of lead poisoning in birds include loss of appetite, lethargy, weakness, emaciation, tremors, drooped wing, and impaired locomotion, balance and depth perception. Toxic and sublethal effects of lead on birds held under controlled conditions vary widely with species, age and sex and the form and dose of lead administered. In general it has been shown that nestlings (juveniles) are more sensitive to the effects of lead than are older birds.

In studies specific to the Refuge, lead poisoning was determined to be a leading cause of mortality in Laysan Albatross in a 3- year study by Work et al. (1998). Two more recent evaluations of lead toxicity in birds at the Refuge were conducted by Finkelstein et al. (2003) and the USFWS (2009a). These studies indicated that elevated blood lead levels were correlated with observable (droop wing) effects found in Laysan Albatross chicks.

2.2. Avian Receptors/Life History

Review of the historical literature and subsequent discussions with Refuge staff (Personal Communication, John Klavitter, Deputy Refuge Manager, April 14, 2010) indicate that there are three avian receptors of concern that should be addressed in the SRE; Laysan Albatross, Bonin Petrel and Laysan Duck (*Anas laysanensis*). Information about the life histories of these species is described below. This information was used in the SRE to assess the level of exposure to lead and in the development of risk-based cleanup levels.

2.2.1. Laysan Albatross

Laysan Albatross are the most abundant species of bird found at the Refuge; approximately 71 percent of the world population of Laysan Albatross nest at the Refuge. They nest on the ground on almost any non-paved surface and return to the same nesting sites annually. Approximately 450,000 breeding pairs were nesting at Midway Atoll (including Sand, Eastern, and Spit islands) in January 2008.

The Laysan Albatross breed each November and egg laying continues until mid-December. Chicks hatch from late January through February and fledge in mid-June through late July. The adults take turns incubating eggs and caring for young, staying on the nest for up to 3 weeks at a time. Most Laysan Albatross do not breed until they are 6 to 8 years old and have a life span of 12 to 40 years (www.fws.gov/midway/laal.html).

The average weight of the Laysan Albatross is 2.4 kilograms; the males are normally larger than the females. The Laysan Albatross is primarily a nocturnal surface feeder, which feeds primarily on squid, fish, crustaceans and flying fish eggs in the open ocean (www.fws.gov/midway/laal.html).

2.2.2. Bonin Petrel

Bonin Petrel is an exclusively nocturnal species of seabird. They feed offshore on squid, fish, and crustaceans and marine insects, and are thought to capture their prey by sitting on the water and by dipping while in flight. Average adult petrels weigh less than one-half of a kilogram (Seto and O'Daniel, 1999).

Bonin Petrels currently nest only on Sand Island. They return to the Refuge in August to excavate burrows in sandy soils for their nests, which can be 5 to 8 feet long and three feet deep. Egg laying begins in January and continues through March. The first eggs hatch in February, but the majority of eggs hatch in March and April. The fledged chicks and adults leave the Refuge by late June and early July.

2.2.3. Laysan Duck

The Laysan Duck has been federally-listed as endangered since 1967 and identified as Critically Endangered by the World Conservation Union (USFWS, 2009b). The Laysan Duck has the most restricted range of any duck in the world, with a single naturally-occurring population on Laysan Island and a small population at the Refuge (birds translocated from Laysan Island). In 2004 and 2005, 42 ducks were transferred from Laysan to the Refuge; the population has grown rapidly and appears to be healthy. The population of Laysan Ducks at the Refuge has increased to almost 473 ducks (December 2010 population).

Average weights for Laysan Ducks vary by age from 98 grams (age 14) to 402 grams (age 42). Laysan Ducks are between 15 and 17 inches in length.

Habitat requirements include vegetation in which to take cover, a prey base of invertebrates, a source of fresh water, and protection from mammalian predators. On Laysan Island and Midway Atoll, the ducks use the following habitats: upland vegetation, ephemeral wetlands, freshwater seeps, mudflats, the Hypersaline Lake (on Laysan Island), and coastal areas. The Laysan Duck generally feeds at night on a wide variety of terrestrial and wetland invertebrates, seeds, and succulent plants. The Laysan Ducks are primarily insect feeders, but may also feed on leaves and seeds (www.fws.gov/pacificislands/fauna/laysanduck.html). The Laysan ducklings have more restrictive requirements than adults because of their high nutritional needs for growth and initial inability to process salt water. The Laysan duckling activities are concentrated near sources of fresh water with nearby cover and high prey densities (USFWS, 2009b).

The Laysan Duck nesting season runs from February and November; however, most eggs are laid between April and August. Nests are built on the ground under thick vegetation, especially bunchgrass (*Eragrostis variabilis*). On Laysan Island, the typical clutch size is around 4 eggs, while the average clutch size at the Refuge in 2005 and 2006 was 7 eggs. Incubation lasts around 28 to 29 days (www.fws.gov/pacificislands/fauna/laysanduck.html).

2.3. Exposure Pathways

Previous risk assessments (1996 SERA, 1997 BERA, and 2004 BERA) at Midway Atoll have evaluated avian exposure to soil via the ingestion, dermal and inhalation exposure pathways. The 1996 SERA concluded that the inhalation pathway was insignificant relative to the ingestion and

dermal exposure pathways. Inhalation exposure pathways were not evaluated in the 1997 BERA (Ogden, 1996 and 1997). The 2004 BERA conducted at the JP-5 Release Site evaluated Bonin Petrel exposure to petroleum-related contaminants in soil and found that potential hazard indices for the soil ingestion exposure pathway were a minimum of five orders of magnitude larger than hazard indices associated with the dermal contact and inhalation exposure pathways (GeoEngineers, 2004). Dermal exposure to lead is limited due to low dermal absorptions rates through skin because feathers help limit the amount of soil in direct contact with the skin. Additional discussion on the correlation of soil ingestion and blood lead levels is provided below.

2.3.1. Soil Ingestion at Midway

Many species of birds ingest soil both deliberately and incidentally. Shorebirds that probe sediments for food incidentally ingest high levels of sediment/soil, as do upland (terrestrial) birds that use soil as part of their digestion. Pelagic piscivorous (fish/shellfish eating) seabirds such as the albatross and petrel are not known to ingest soil or sediment either incidentally or deliberately as part of their dietary behavior. However, because both the albatross and petrel nest on or under the ground, they may be exposed incidentally to soil during nesting activities. The Laysan Duck may be incidentally exposed through the ingestion of sediment during foraging for aquatic insects and other invertebrates.

2.3.2. Correlation of Blood Lead and Soil Lead Levels

In evaluating exposure to lead at the Refuge by ingestion, Finkelstein et al. (2003) found no correlation between isotopic compositions of lead in soil at albatross nesting sites and lead in albatross chick blood, but did find a correlation between blood lead isotopic compositions of albatross chicks with droop wing and lead isotopic compositions of paint chips from the affected chick's nests. These results lead this group to conclude that ingestion of LBP chips by albatross chicks, and not the indirect ingestion of soil, was the primary source and exposure of lead in these birds. The 2009 FWS ERA conducted a similar evaluation of blood lead levels and soil lead concentrations and again similarly concluded that little to no correlation exists between lead in soil and blood lead in the albatross. The highest blood lead levels were correlated with the proximity of nest sites to buildings contained LBP. The 2009 ERA did, however, conclude that lower soil concentrations generally correlate with lower avian blood lead levels.

Applying the conclusions of both these studies, avian exposure (Albatross, petrel and Laysan Duck) appears to driven by the proximity of bird nesting sites to buildings that contain lead-based paint and by the direct or indirect ingestion of paint chips by chicks using these nest sites. Indirect ingestion of paint chips may include the ingestion of ground, crushed, or pulverized paint chip during the incidental ingestion of soil. The exposure of these birds through the ingestion, dermal contact and inhalation of lead in soil without paint chips appears to be negligible relative to the ingestion of paint chips and paint chip-containing soil.

2.4. CSM Conclusions

GeoEngineers developed the CSM based on a review of site-specific historical studies, personal communications and the potential for exposure and toxicity of lead to avian receptors. From this information we draw the following conclusions:

- Lead is toxic to avian wildlife according the scientific literature and based on direct observations of lead toxicity in avian receptors on Sand Island (droop wing in Albatross chicks).
- Prior avian studies at Sand Island have correlated blood lead levels to the presence of paint chips and nesting sites, but there is not a strong correlation between levels of lead found in the soil and blood lead levels. The lack of a correlation between soil lead and blood lead concentration is likely partly due to the direct ingestion of paint chips by Albatross chicks in addition to any incidental ingestion of soil. However, studies available in the scientific literature do show a correlation between dietary lead concentrations and blood lead levels. Three of these studies are discussed in Section 3.1.1 of this appendix.
- In meeting the objectives of the EE/CA, groundwater and surface water were not considered sources of potential lead contamination at Midway.
- The inhalation and dermal contact of lead in avian receptors at the Refuge presents negligible toxicity when compared to the ingestion pathway.
- Two species of birds (Laysan Albatross and Bonin Petrel) are the most likely receptors to be exposed to potential lead contamination. However, based on discussions with FWS, the Laysan Duck was also considered in this SRE.
- The albatross appears to be the most highly exposed due to the proximity of nesting sites to lead contaminated buildings. There is a high correlation between blood lead levels and the presence of lead-based paint chips adjacent to these nesting sites.
- In the absence of observable paint chips, the petrel represents the highest level of incidental soil exposure due to this species burrowing/nesting behavior.
- The Laysan Duck appears to have the lowest level of lead exposure because this species has high levels of nesting and foraging activity in non-lead-impacted wetland areas on Midway. The Laysan Duck may be exposed through limited terrestrial or upland foraging.

These conclusions provide the basis for developing two lines of evidence for assessing lead risk to avian receptors at the Refuge and for completing the SRE. The two lines of evidence that we propose are:

- Correlating blood lead levels to soil lead concentrations, based on information from the scientific literature; and
- Developing a risk-based concentration (RBC) approach for lead in soil that will be protective of the Bonin Petrel, which has the highest exposure to soil, and the Laysan Albatross and Laysan Duck.

The approach to developing the two lines of evidence is discussed in Sections 3.1 and 3.2 below.

3.0 RISK APPROACH

The potential risk to the avian receptors at Sand Island from exposure to LBP and lead contaminated soil were evaluated using a line-of-evidence (LOE) approach. Numerous studies at Sand Island have shown that ingesting LBP chips from buildings and LBP chips and soil from the ground have caused mortality and other visible effects of lead poisoning in seabirds, including

droop wing. The primary receptors that have shown these effects are Laysan Albatross chicks (USFWS, 2009a; Finkelstein et al., 2003; Sileo et al., 1990; Sileo and Fefer, 1987). The focus of the SRE is to evaluate avian exposure to soil that contains either ground, crushed, or pulverized LBP chips because field sampling has focused on LBP that has migrated to the soil. .

Desk-top RBC modeling and avian blood lead and dietary lead correlations from the scientific literature are presented as the two primary LOE for recommending a cleanup level. The goal of the SRE is to recommend a cleanup level for lead in soil that is representative of both LOE. Additionally, the soil and blood lead data from the USFWS (2009) ERA are evaluated to ground truth the recommended cleanup level.

These LOE, along with other parameters presented in the EE/CA, are used to develop a soil lead cleanup level that is protective of avian receptors at the Refuge including Laysan Albatross, Bonin Petrel, and Laysan Duck. The soil lead RBC will be used in part to help identify removal actions for lead contaminated soil in the vicinity of buildings and to ground-truth the assumptions made in the avian exposure modeling (described in 3.2 of this appendix) as they relate to effects identified through blood lead levels in avian receptors (described in Section 3.1 of this appendix).

The soil PCGs were developed for the Bonin Petrel (the most highly exposed receptor to soil) due to their nesting behavior (underground burros). The soil PCGs that are protective of the Bonin Petrel are expected to be protective of Laysan Albatross chicks and the Laysan Duck. The following sections present a summary of the two LOE approaches followed by our recommendations for a soil PCG.

3.1. Avian Blood Lead and Soil/Dietary Lead Relationship

The results of a number of field and laboratory studies evaluating both soil lead concentrations and blood lead concentrations in avian test species were reviewed to determine if there is a relationship (linear regression) between the concentration of lead in soil and blood.

Attempts at meaningful relationships between blood lead and soil lead were not successful with prior field studies at Sand Island because the ingestion of LBP in the chips was determined to be the primary route of exposure to the albatross chicks and not through the indirect ingestion of soil (Sileo and Fefer, 1987; Sileo et al., 1990; Finkelstein et al., 2003). Data in the USFWS (2009a) study were variable and efforts to develop a relationship between the concentration of lead in blood and soil were also unsuccessful.

3.1.1. Review of Available Literature

Of the applicable data that were reviewed, the data sets for three primary laboratory studies conducted by Connor et al. (1994), Heinz et al. (1999) and Day et al. (2003) were used to establish a correlation between dietary lead and blood lead concentrations. These three studies, which were conducted using northern bobwhites, mallards and mute swans, respectively, were selected for our analysis because: 1) the studies used reliable laboratory controls; 2) lead was incorporated into the diet of the birds who were allowed to feed voluntarily; 3) gavage or injection was not used to administer a dose to the birds; 4) the studies used similar analytical methods to measure blood lead as µg-lead/g-blood weight wet (µg/g-ww) and dietary lead as a concentration in food in µg-

lead/g-food dry weight; dietary lead studies are not available for Laysan Albatross, Bonin Petrel, or the Laysan Duck.

The analytical data from these three studies are presented in Table C-1. The results of the correlation analysis indicate a strong relationship (R^2 = 0.8293) between blood lead and soil lead as shown on Figure C-2.

3.1.2. Extrapolating Blood Lead to Soil Lead

The purpose of establishing a relationship between dietary lead and blood lead concentrations was to determine a soil lead concentration that is protective of an "acceptable" blood lead concentration in avian receptors. Using the data from the three studies discussed above and presented in Table C-1, a correlation (linear regression) was established. The results of the correlation analysis indicate a strong relationship (R^2 = 0.8293) between dietary lead and blood lead as shown on Figure C-2. This relationship is used below to correlate blood lead concentrations to soil lead concentrations since soil is assumed to make up a portion of the Bonin Petrel diet. As noted in Section 2.4, a soil concentration protective of the Bonin Petrel is expected to be protective of the Laysan Albatross and Laysan Duck because the petrel has the highest exposure to soil.

The Finkelstein (2003) study conducted at the Refuge reported a geometric mean of 4.5 µg/dL for blood lead in albatross chicks from a non-LBP building reference site, a geometric mean of 48 µg/dL in non-droop wing chicks from known LBP buildings, and a geometric mean of 190 µg/dL in "droop-wing" albatross chicks from known LBP buildings. Using the blood-soil linear regression and extrapolating from these blood lead levels, results in soil lead concentrations of approximately 48, 119, and 352 mg/kg, respectively.

Franson (1996) evaluated lead concentrations in avian tissue, including blood, liver, and kidney. Franson found sufficient data for Falconiformes (e.g., falcons, eagles), Columbiformes (e.g., doves, pigeons), and Galliformes (e.g., turkeys, pheasants) to categorize the blood lead levels into three categories: 1) subclinical (physiological effects only, bird would likely recover if exposure were eliminated), 2) toxic (severe physiological effects, leading to clinical signs of toxicity or death if exposure were not eliminated), and 3) compatible with death. The blood lead levels for these three categories were lowest for Falconiformes and are as follows:

- Subclinical = 0.2 to 1.5 milligrams per kilogram -wet weight (mg/kg-ww) (20 to 150 µg/dL),
- Toxic = >1 mg/kg-ww (>100 µg/dL), and
- Compatible with Death = >5 mg/kg (>500 µg/dL).

The blood lead level of 20 µg/dL, which is the low end of the subclinical effects range identified by Franson (1996), was assumed to be the "acceptable" blood lead concentration. This blood lead concentration was reported by Franson (1996) as being protective of various species of falconiforme, columbiforme and galliforme bird species. Eisler (1988) identified avian blood lead levels greater than 20 µg/dL as being "elevated." The soil lead concentration associated with a blood lead level of 20 µg/dL is 75 mg/kg.

3.2. Risk-Based Concentration: Avian Exposure Modeling

This section presents GeoEngineers' approach to modeling a soil lead PCG or RBC in soil. The RBC was used in the EE/CA to delineate the extent of soil requiring removal after soil with visible paint chips has been removed. The RBC was developed for the Bonin Petrel because it is the most highly-exposed receptor and the resulting RBC should be protective of the Laysan Albatross and Laysan Duck. Bonin Petrel exposure to soil was assumed to occur entirely within their nesting burrows since they obtain their diet directly from the ocean. The soil lead RBC did not consider avian exposure to paint chips because studies have shown that the LBP in chips near buildings are adversely affecting Laysan Albatross chicks and would need to be removed as part of any removal action (USFWS, 2009a; Finkelstein et al., 2003; Sileo et al., 1990; Sileo and Fefer, 1987).

Using the justification as presented in Section 2.3 of this appendix, the RBC will be based on the ingestion of lead in soil as the primary avian exposure pathway to lead in soil.

The goal of the RBC is to model the level of lead in soil that the Bonin Petrel can come in contact with and not result in adverse effects. Assumptions about the Bonin Petrel soil ingestion rates and toxicity to lead are discussed below.

Bonin Petrel exposure factors, threshold reference values, and risk-based concentration calculations are presented in Tables C-2 through C-4.

3.2.1. Bonin Petrel Intake Modeling

The daily intake of compounds was estimated for the Bonin Petrel using scientifically accepted methodology. For ecological receptors like the petrel, which can be exposed through various routes of exposure, daily intake models have been developed that express exposure in terms of constituent intake per kilogram of body weight per day (mg/kg/day). The intake models are constituent-specific and incorporate exposure point concentration data as well as receptor-specific information such as the frequency of exposure, body weight and soil ingestion rate. Intake rates were estimated using allometric models, based on body weight.

Allometric modeling is a common approach to estimate intake rates when empirical data for a particular species is unavailable (USEPA, 1993). Allometric models are developed through regression analysis and are based on positively-correlated relationships between parameters such as body weight, body size, and ingestion rate. Allometric models are often developed for mammals or birds or specific groups of mammals or birds. Allometric models that were based on body weight have been used to estimate soil ingestion for the petrel as discussed below.

Both the allometric models and the intake models are discussed in the following sections.

3.2.1.1. SOIL INGESTION

Soil ingestion rates have been estimated for only a few wildlife species and are not specifically available for the petrel. GeoEngineers estimated a soil ingestion rate for the petrel by first estimating the petrel's dietary ingestion rate and then applying a percentage of that rate as incidental soil ingestion. A dietary ingestion rate for sea birds using an allometric equation developed by EPA (1993) was used for the petrel based on a typical petrel body weight of 0.2037 kg (Seto and O'Daniel, 1999).

We assumed an incidental soil ingestion rate of 20 percent of the dietary intake, based on the 95th percentile soil ingestion fraction (i.e., proportion of food intake that is soil) for the Woodcock (USEPA, 2005b). EPA's Eco-SSL guidance (USEPA, 2005a) estimated soil ingestion fractions for three receptor groups using Monte Carlo analyses (dove, hawk, and woodcock), which were intended to represent herbivores, carnivores, and ground insectivores, respectively. The woodcock had the highest estimated soil ingestion fraction of these three groups. EPA selected the 90th percentile soil ingestion fraction value of the estimated distribution for each receptor group (5.7 to 16.4%) as the most appropriate high-end point estimate value to use in the calculation of Eco-SSLs The 95th percentile soil ingestion fraction was selected for this risk assessment to incorporate another level of conservativeness and because of the lack of available data on the petrel's underground nesting behavior as it relates to soil ingestion while also considering that the petrel is closely associated with potentially-contaminated subsurface soil.

The allometric model for incidental soil ingestion by the petrel is represented by the following equation:

$$ING_{soil} = 0.495 \times BW_{petrel}^{0.704} \times \%_{soil} \qquad \text{Equation 1}$$

Where:

ING_{soil} = Ingestion rate for soil (g/day)

BW_{petrel} = Body weight for the petrel (g)

$\%_{soil}$ = Amount of soil ingested as a percent of total diet (unitless)

3.2.1.2. INTAKE

The intake models for estimating the petrel's exposure through ingestion of soil are presented below. This equation incorporates the soil ingestion rate from Equation 1, exposure point concentration (i.e., soil lead concentration), and petrel body weight. A conversion factor of 0.001 was used to convert between units of measure used in Equation 1, above (g), and those used in Equation 2, below (kg). The area use factor is based on a 3 month migration period to and from Japan (Seto and O'Daniel, 1999), during which time petrels would not be exposed to contamination on the island.

$$EDI = \frac{EPC_{soil} \times ING_{soil} \times CF}{BW_{petrel}} \times AUF_{petrel} \qquad \text{Equation 2}$$

Where:

EDI = Estimated daily intake of lead (mg/kg/day)

EPC_{soil} = Exposure point concentration in soil (mg/kg)

ING_{soil} = Ingestion rate for soil (g/day)

BW_{petrel} = Body weight of petrel (kg)

CF = Conversion factor (kg/g)

AUF = Area use factor defining petrel's frequency of exposure to soil (unitless).

3.2.2. Toxicity

This section describes methodology that was used to obtain data on toxicological effects of avian exposure to lead and to derive the TRVs from the data. The potential for adverse ecological effects was evaluated using lead toxicity data from literature for target receptors.

3.2.2.1. METHODOLOGY

EPA Eco-SSLs for lead in 2005 (USEPA, 2005a, 2005b). Eco-SSLs were developed for plants, invertebrates, avian wildlife and mammalian wildlife. EPA initially reviewed 2,429 papers to evaluate avian and mammalian toxicity. Following the Eco-SSL guidance (EPA, 2005a), toxicity data from 54 papers was used to derive an avian TRV, which was then used to calculate three separate avian Eco-SSLs (avian herbivore, avian ground insectivore and avian carnivore). The 54 papers included 106 results for biochemical, behavioral, physiology, pathology, reproduction, growth and survival.

EPA used the NOAEL results for growth and reproduction to calculate a geometric mean NOAEL of 10.9 mg/kg/day. This geometric mean was then compared to the lowest bounded lowest observed adverse effect level (LOAEL) for reproduction, growth and survival (a bounded LOAEL is an LOAEL that is paired with an NOAEL from the same study). Because the geometric mean NOAEL was greater than the lowest bounded LOAEL, EPA set the avian TRV equal to the highest bounded NOAEL that is lower than the lowest bounded LOAEL for reproduction, growth, or survival or 1.63 mg/kg/day.

The avian TRV of 1.63 mg/kg/day was the NOAEL dose based on reproductive effects from a study conducted by Edens and Garlich (1983). Chickens (Gallus domesticus) were exposed to lead acetate in their diet at concentrations of 0, 25, and 50 mg/kg for a period of 4 weeks. The NOAEL and LOAEL concentrations were 25 and 50 mg/kg, respectively. The LOAEL dose from this study was 3.26 mg/kg/day.

To provide a range of potential risk estimates and RBCs, avian TRVs of 1.63 mg/kg/day and 3.26 mg/kg/day, based on the NOAEL and LOAEL doses from the Edens and Garlich (1983) paper were used, along with exposure factors described in Section 3.2.1 above, to evaluate bonin petrel exposure to lead contaminated soil.

Effects data such as TRVs are commonly modified for a species of concern (i.e., bonin petrel) by allometrically adjusting the dose for differences in body weight using methodology from Sample and Arenal (1999) as follows:

$$TRV_p = TRV_t \left[\frac{BW_t}{BW_p} \right]^{(1-1.2)} \qquad \text{Equation 3}$$

where:

TRV_p = Adjusted TRV for petrel (mg/kg/d)

TRV_t = TRV for avian test species (mg/kg/d)

BW_t = Body weight of avian test species (kg)

BW_p = Body weight of target species (kg)

The avian TRVs presented above were not adjusted because the EPA avian Eco-SSLs, which were derived using the NOAEL avian TRV, are intended to be "protective of the conservative end of the exposure and effects species distribution" (EPA, 2005b).

Uncertainty factors were not required because 1) only toxicity data for avian species were evaluated and 2) EPA's avian TRV was based on a chronic NOAEL.

3.2.2.2. SELECTED TRVS

The NOAEL and LOAEL lead TRVs of 1.63 mg/kg/day and 3.26 mg/kg/day used in this risk assessment are consistent with lead avian TRVs cited in the literature. The California Department of Toxic Substances Control (DTSC), Human and Ecological Risk Division (HERD), derived lead High and Low Regional TRVs – Birds of 8.75 mg/kg/day and 0.014 mg/kg/day (DTSC-HERD, 2000). DTSC-HERD summarized avian toxicity criteria with a range of lead values from 0.014 mg/kg/day to 26 mg/kg/day (DTSC-HERD, 2000). FWS derived lead NOAEL and LOAEL TRVs for birds of 1.5 mg/kg/day and 15 mg/kg/day in the ecological risk assessment for the Prime Hook National Wildlife Refuge (USFWS, 2004). Also, Sample et al. (1996) used NOAEL and LOAEL lead acetate doses of 1.13 mg/kg/day and 11.3 mg/kg/day and an NOAEL metallic lead dose of 3.85 mg/kg/day to calculate toxicological benchmarks for avian exposure to lead.

3.2.3. Risk-Based Concentration Methodology

Risk to potential receptors is generally quantified using standard hazard quotient (HQ) methodology (USEPA, 1997). Under this approach, (HQ) posed to the receptor is calculated for each contaminant of potential ecological concern (CPEC) and appropriate exposure route by dividing the receptor's estimated daily intake (EDI), from Equation 2 above, by the appropriate TRV from Equation 3. This comparison is made for each CPEC and is expressed as:

$$HQ = \frac{EDI}{TRV_{petrel}} \qquad \text{Equation 4}$$

Where EDI equals the estimated daily intake of lead and TRV equals the toxicity reference value for the CPEC for the same exposure route. An HQ less than 1 indicates that the exposure is less than the TRV, which is typically regarded as having negligible risk. An HQ significantly greater than 1 suggests the receptor may be exposed to unacceptable risk. It may be necessary to remediate or further study contaminated soil with an HQ greater than 1 (USEPA, 1997).

The RBC, shown in Equation 5 below, represents a concentration in soil that, if exceeded, is likely to result in daily intake from ingestion that poses a risk to the receptor. The RBC is calculated by setting HQ (the risk threshold) equal to 1 and rearranging Equations 2 (EDI) and 4 (HQ) to solve for the EPC (or RBC). The Bonin Petrel RBC for lead in soil was calculated using the following equation:

$$RBC = \frac{HQ \times BW_{petrel} \times TRV_{petrel}}{ING_{soil} \times CF \times AUF_{petrel}} \qquad \text{Equation 5}$$

3.2.4. Range of Lead RBCs

Lead soil PCGs for the Bonin petrel range from 106 to 212 mg/kg when using the RBC equation above with a low TRV of 1.63 mg /kg/day and a high TRV of 3.26 mg/kg/day and a 20 percent soil ingestion rate. The low cleanup level represents a NOAEL and is considered protective of individual avian receptors at Sand Island.

As noted above, the 20 percent soil ingestion rate was selected to conservatively estimate the amount of soil ingested by Bonin Petrel. EPA (2005a) recommended soil ingestion rates of 5.7, 13.9, and 16.4 percent for the hawk, dove, and woodcock, respectively. Using the low TRV of 1.63 mg/kg/day and these three soil ingestion rates corresponds to lead soil concentrations of 372 mg/kg, 152 mg/kg, and 129 mg/kg.

4.0 RECOMMENDED CLEANUP VALUE

The justification for recommending an appropriate PCG is whether blood lead levels in the range of 20 to 100 µg/dL from Franson (1996) are indicative of subclinical toxicity above which adverse effects may occur to avian receptors at Sand Island including the Bonin petrel, Laysan albatross and Laysan duck.

Adopting this range as an approximate threshold for adverse effects in avian receptors and using the modeled lead RBC for Bonin petrel as well as evidence from GeoEngineers' blood-soil lead regression analysis indicate that a soil lead cleanup level of 75 mg/kg would be an appropriate value to protect individual avian receptors at Sand Island.

Justification for a cleanup value of 75 mg/kg is as follows:

- Using the linear regression that GeoEngineers developed, the PCG of 75 mg/kg equates to a blood lead level of 20 µg/dL, which falls at the low end of the 20 to 100 µg/dL range reported by Franson (1996) as being protective of various species of falconiforme, columbiforme and galliforme bird species.
- The Bonin Petrel RBC that GeoEngineers calculated was based on a NOAEL TRV of 106 mg/kg and represents the protection of avian species at the individual level, which is consistent with EPA CERCLA guidance for ecological risk assessment. The recommended PCG of 75 mg/kg is less than the NOAEL based Bonin Petrel RBC of 106 mg/kg.
- GeoEngineers evaluated the USFWS (2009a) ERA soil and blood lead data relative to the 20 µg/dL blood lead threshold evaluated in this SRE by calculating the 95th and 99th percentile blood lead concentrations. The 103 soil and corresponding blood lead data points were first ranked from the lowest to the highest soil concentration. The percentiles were then calculated using the blood lead concentration associated with the lowest soil concentration, the blood lead concentrations associated with the two lowest soil concentrations, the three lowest soil concentrations, up to the blood lead concentrations associated with all 103 soil samples. Soil levels were then identified as the lead concentrations in the samples immediately before the

sample where the 95th or 99th percentile blood lead concentration exceeded 20 µg/dL. These soil concentrations are 74 mg/kg for the 99th percentile blood lead concentration and 107 mg/kg for the 95th percentile blood lead concentration. In other words, at a soil concentration of 74 mg/kg, 99 percent of Laysan Albatross chicks would be expected to have a blood lead concentration less than 20 µg/dL.

- Evidence from Franson (1996) and others suggests that tissue lead residues including blood, kidney and liver that are associated with chronic lead poisoning in avian receptors can generate adverse effects in these species well before the onset of physiological injury and death. Therefore, a PCG that is based on the low end of the subclinical range of toxicity should be protective of birds prior to additional exposures that may be lethally toxic.
- The current residential EPA Regional Screening Level for lead in soil is 400 mg/kg (EPA, 2010). However, soil lead cleanup levels are being reevaluated across the country. For example, California EPA revised their residential and industrial soil California Human Health Screening Levels for lead to 80 mg/kg and 320 mg/kg, respectively (Cal-EPA, 2009). In addition, the Washington State Department of Ecology (Ecology) is considering revising the Model Toxics Cleanup Act (MTCA) Method B lead soil cleanup level for unrestricted use (aka, residential) from 250 mg/kg to around 100 to 150 mg/kg (Ecology, 2010).

5.0 REFERENCES

Cal-EPA, Revised California Human Health Screening Levels for Lead, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, September 2009.

Connor et al., "Bioavailability of Lead from Contaminated Sediment in Northern Bobwhites, *Colinus virginianus,*" Archives of Environmental Contamination and Toxicology, 27: 60–63, 1994.

Day et al., "Toxicity of Lead Contaminated Sediment to Mute Swans," Archives of Environmental Contamination and Toxicology, 44: 510-522, 2003.

DTSC-HERD, HERD Ecological Risk Assessment (ERA) Note Number 4. Use of Navy/U.S. Environmental Protection Agency (USEPA) Region 9 Biological Technical Risk Assistance Group (BTAG) Toxicity Reference Values (TRVs) for Ecological Risk Assessment, December 8, 2000.

Ecology, Updating Cleanup Levels for Lead-Contaminated Soils. Discussion Materials. Prepared for the MTCA/SMS Advisory Group, March 2010.

Edens, F. W. and Garlich, J. D., "Lead-induced Egg Production Decrease in Leghorn and Japanese Quail Hens." Poultry Science, 62(9): 1757-1763, 1983.

Eisler, R., Lead Hazards to Fish, Wildlife and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service, Contaminant Hazard Reviews, Report No. 14, U.S. Fish and Wildlife Service, Laurel, Maryland, 1988.

Finkelstein et al., "Lead Poisoning of Seabirds: Environmental Risks from Leaded Paint at a Decommissioned Military Base." Environmental Science and Technology, 37: 3256-3260, 2003.

Franson, Interpretation of Tissue Lead Residues in Birds Other than Waterfowl. In "Environmental Contaminants in Wildlife, Interpreting Tissue Concentrations." W.N. Beyer, G.H. Heinz and A.W. Redmon-Norwood, eds. Society of Environmental Toxicology and Chemistry, Special Publication Series, Lewis Publishers, Boca Rotan, Florida, 1996, pp. 265-279.

GeoEngineers, Inc., Draft Remedial Investigation Report, February 2003, JP-5 Release, U.S. Fish and Wildlife Service, Sand Island, Midway Atoll National Refuge, December 30, 2004.

Heinz et al., "Toxicity of Lead Contaminated Sediment to Mallards," Archives of Environmental Contamination and Toxicology, 36: 323-333, 1999.

Ogden, Naval Air Facility (NAF) Midway Island Site Inspection (SI) Report, Ogden Environmental and Energy Services Co., Inc., January 1996.

Ogden, Remedial Investigation (RI) Report for Naval Air Facility (NAF) Midway Island, Volume I: Technical Report, July 1997.

Reeder, W.H., "Stomach Analysis of a Group of Shorebirds," Condor, 53:43-45, 1951.

Sample et al., Toxicological Benchmarks for Wildlife: 1996 Revision, ES/ER/TM-86/R3, June 1996.

Sample, B.E. and Arenal, C.A., "Allometric Models for Interspecies Extrapolation of Wildlife Toxicity Data," Bulletin of Environmental Contamination and Toxicology, 62:653-663, 1999.

Seto N. W. H. and O'Daniel, D., The Birds of North America: Bonin Petrel, No. 385, 1999.

Sileo et al., "Causes of Mortality of Albatross Chicks at Midway Atoll," Journal of Wildlife Diseases 1987; 26(3) 329-338, 1990.

Sileo, L. and Fefer, S.I., "Paint Chip Poisoning of Laysan Albatross at Midway Atoll." Journal of Wildlife Diseases 1987; 23(3) 432-437, 1987.

USEPA, Wildlife Exposure Factors Handbook. Volumes I and II. EPA/600/R-93/187, 1993.

USEPA, Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. Interim Final, Solid Waste and Emergency Response, Environmental Protection Agency, EPA 540-R-97-006, 1997.

USEPA, 2005a, Guidance for Developing Ecological Soil Screening Levels, OSWER Directive 9285.7-55, November 2003, revised February 2005.

USEPA, 2005b, Ecological Soil Screening Levels for Lead, Interim Final, OSWER Directive 9285.7-70, March 2005.

USFWS, Ecological Risk Assessment for the Prime Hook National Wildlife Refuge Lead Shot Site, Milton, Delaware, CBFO-C03-04, August 2004.

USFWS, 2009a, Ecological Risk Assessment for Lead in Soil and Laysan Albatross Chicks on Sand Island, Midway Atoll National Wildlife Refuge, U.S. Fish and Wildlife Service, September 24, 2009.

USFWS, 2009b, Revised Recovery Plan for the Laysan Duck (Anas laysanensis), U.S. Fish and Wildlife Service, Portland, Oregon, 2009, pp. lx + 114.

Work et al., "Necrotizing Enteritis as a Cause of Mortality in Laysan Albatross, Diomedea immutabiliss, Chicks on Midway Atoll, Hawaii," Avian Diseases 42(1): 1-5, 1998.

TABLE C-1

Summary of Blood Lead and Dietary Lead Study Data[a]

MIDWAY ATOLL NWR REMEDIAL INVESTIGATION

Study	Blood Lead		Diet Lead		Blood Lead		Diet Lead		Blood Lead		Diet Lead		Blood Lead		Diet Lead		Blood Lead		Diet Lead		Blood Lead		Diet Lead		Blood Lead		Diet Lead		Notes
	Conc.	Units[b]	Conc.	Units[b]	Conc.	Units[b]	Conc.	Units[b]	Conc.	Units[b]	Conc.	Units[b]	Conc.	Units[b]	Conc.	Units[b]	Conc.	Units[b]	Conc.	Units[b]	Conc.	Units[b]	Conc.	Units[b]	Conc.	Units[b]	Conc.	Units[b]	
Toxicity of Lead-Contaminated Sediment to Mute Swans. Day et al., 2003	0.19	ug/g-ww	<2	ug/g-dw	0.2	ug/g-ww	5.8	ug/g-dw	1.28	ug/g-ww	460	ug/g-dw	2.3	ug/g-ww	850	ug/g-dw	--	ug/g-ww	<2	ug/g-dw	0.2	ug/g-ww	4.4	ug/g-dw	3.2	ug/g-ww	700	ug/g-dw	Swans were fed for 6 weeks consisting of maintenance or rice diets treated with 0, 12 or 24% highly contaminated sediment or 24% reference sediment. Mute swan body weight averaged between 7.5 and 8.1 kg at the beginning of the study. Sublethal lead poisoning was measured in the birds as decreased body weight, nephrosis, bile reductions and significant reductions in hematocrit and hemoglobin concentrations.
Toxicity of Lead-Contaminated Sediment to Mallards. Heinz et al., 1999 (Experiment #1)	0.03	ug/g-ww	<0.5	ug/g-dw	0.04	ug/g-ww	2.5	ug/g-dw	1.1	ug/g-ww	103	ug/g-dw	1.7	ug/g-ww	207	ug/g-dw	3	ug/g-ww	414	ug/g-dw	6.9	ug/g-ww	828	ug/g-dw	N/A	--	N/A	--	Experiment 1 lasted approximately 10 weeks with mallards ranging in body weight from 1.202 kg to 1.336 kg. Treatments consisted of 24% uncontaminated sediment in control diet and 3, 6, 12, and 24% lead contaminated sediment in diet. In all 3 experiments lead poisoning was measured as atrophy of the beast muscles, green staining of the feathers around the vent, viscous bile, green staining of the gizzard lining and renal tubular intranuclear inclusion bodies.
Toxicity of Lead-Contaminated Sediment to Mallards. Heinz et al., 1999 (Experiment #2)	--	ug/g-ww	<0.2	ug/g-dw	0.09	ug/g-ww	8.7	ug/g-dw	3	ug/g-ww	642	ug/g-dw	6.8	ug/g-ww	1284	ug/g-dw	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	Experiment 2 lasted approximately 5 weeks with mallards ranging in body weight from 1.100 kg to 1.153 kg. Treatments consisted of a control diets with 0% and 48% uncontaminated sediment added and 24 and 48% lead-contaminated sediment in diet.
Toxicity of Lead-Contaminated Sediment to Mallards. Heinz et al., 1999 (Experiment #3)	0.2	ug/g-ww	3	ug/g-dw	0.13	ug/g-ww	3.7	ug/g-dw	4.1	ug/g-ww	954	ug/g-dw	4	ug/g-ww	869	ug/g-dw	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	Experiment 3 lasted approximately 15 weeks with mallards average body weight of 1.200 kg for the commercial diet and 1.000 kg for the corn diet. Treatments consisted of commercial and corn diets with 24% uncontaminated sediment added and commercial and corn diets with 24% lead-contaminated sediment added.
Bioavailability of Lead from Contaminated Sediment in Northern Bobwhites, Colinus virginianus. Connor et. al., 1994	0.63	ug/g-ww	--	ug/g-dw	1.26	ug/g-ww	360	ug/g-dw	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	Northern Bobwhites were fed for 21 days consisting of a control diet of ground poultry ration or ground poultry ration spiked with 8% sediment.

Notes:

[a]Blood lead and dietary lead concentrations presented in this table as presented in referenced papers.

[b]In Figure C-2, blood lead concentrations converted to µg/dL (µg/dL = µg/g-ww * 106 g/dL [assuming a blood density of 1.06 g/mL])

kg = kilogram

µg/g-dw = micrograms per gram - dry weight

µg/g-ww = micrograms per gram - wet weight

n/a = not applicable

TABLE C-2

BONIN PETREL EXPOSURE FACTORS

MIDWAY ATOLL NWR REMEDIAL INVESTIGATION

Parameter	Units	Exposure Factors	Comment	Reference
Ingestion Rate - ING	g/day	4.2	Ingestion rate for soil based on 20% of the dietary ingestion rate, which was calculated using an allometric equation for sea birds.	EPA (1993, 2005)
Conversion Factor - CF	kg/g	1.0E-03	--	--
Area Use Factor - AUF	unitless	0.75	Area use factor based on a 3 month migration period to and from Japan.	Seto and O'Daniel (1999)
Body Weight - BW	kg	0.2037	Body weight based on a mean of body weights measured for 100 petrel residing at Midway Island.	Seto and O'Daniel (1999)

Notes:

USEPA, 1993. Wildlife Exposure Factors Handbook.
EPA, 2005a. Guidance for Developing Ecological Soil Screening Levels, Attachment 4-1.
Seto and O'Daniel, 1999. The Birds of North America: Bonin Petrel. No. 385.
g/day = gram per day
kg/g = kilograms per gram

TABLE C-3

BONIN PETREL TOXICITY REFERENCE VALUE CALCULATIONS[a]

MIDWAY ATOLL NWR REMEDIAL INVESTIGATION

COPEC	Test Species	Test Concentration in Food (mg/kg)	Food Ingestion Rate (g/day)	Test Species Body Weight (kg)	Conversion Factor (g/kg)	Dose (mg/kd/day)	Endpoint [b]	Duration	Route	Effect	Endpoint Uncertainty Factor	Interspecies Uncertainty Factor	TRV [c] (mg/kg/day)
Lead (acetate)	Chicken	25	118	1.81	1,000	1.63	Chronic NOAEL	4-weeks	Oral - diet	Reproduction	1	1	1.63
Lead (acetate)	Chicken	50	118	1.81	1,000	3.26	Chronic LOAEL	4-weeks	Oral - diet	Reproduction	1	1	3.26

Notes:

[a] Edens and Garlich, 1983 and EPA, 2005b

[b] Chronic endpoints were based on study durations of greater than 3-days for birds according to methodology from EPA (2005a; Table 1.1).

[c] Chronic NOAEL TRV was calculated by dividing the listed dose by the appropriate interspecies uncertainty factor according to methodology from Dourson et al. (1996) and the appropriate endpoint uncertainty factor according to methodology from EPA (1997e). The chronic LOAEL TRV was calculated in a similar manner in order to provide a range of toxicity values.

COPEC = Contaminant of potential ecological concern

TRV = Toxicity reference value

NOAEL = No observed adverse effect level

LOAEL = Lowest observed adverse effect level

mg/kg = milligram per kilogram

g/day = gram per day

kg = kilogram

TABLE C-4

RISK-BASED CONCENTRATIONS FOR BONIN PETREL

SOIL INGESTION

MIDWAY ATOLL NWR REMEDIAL INVESTIGATION

COPEC	Hazard Quotient [a]	Body Weight (kg)	TRV [b] (mg/kg-day)	Ingestion Rate (g/day)	Conversion Factor (kg/g)	Area Use Factor (unitless)	Risk-Based Concentration (mg/kg)
Lead	1.0	0.204	1.63	4.2	0.001	0.75	106
Lead	1.0	0.204	3.26	4.2	0.001	0.75	212

Notes:

[a] A Hazard Quotient equal to one represents the threshold at which chemical conentration may pose a risk to Bonin Petrel.

[b] Refer to Table C-3 for TRV derivation.

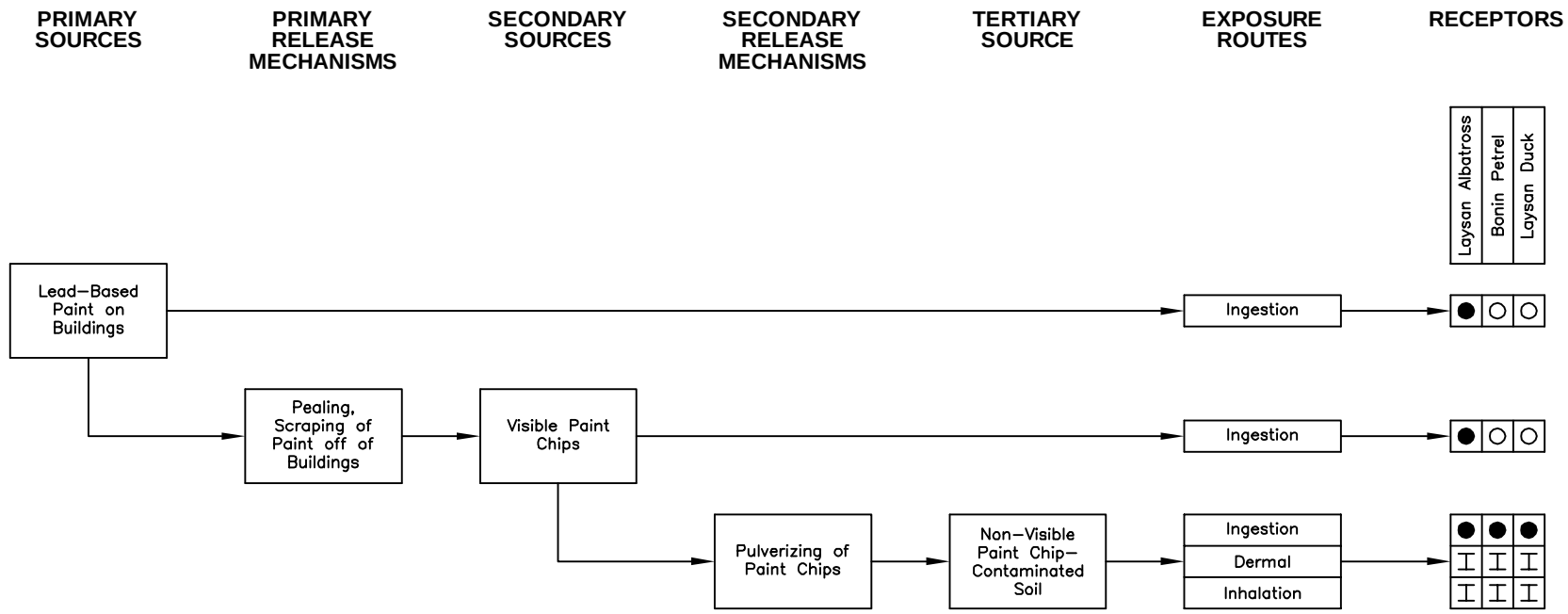
COPEC = Contaminant of Potential Ecological Concern

TRV = Toxicity Reference Value

mg/kg = milligram per kilogram

g/day = gram per day

kg = kilogram



EXPLANATION:

- ● COMPLETE EXPOSURE PATHWAY
- ○ INCOMPLETE EXPOSURE PATHWAY
- I COMPLETE, BUT INSIGNIFICANT EXPOSURE PATHWAY

Notes:

1. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Ecological Conceptual Site Model

Engineering Evaluation and Cost Analysis
Midway Atoll National Wildlife Refuge

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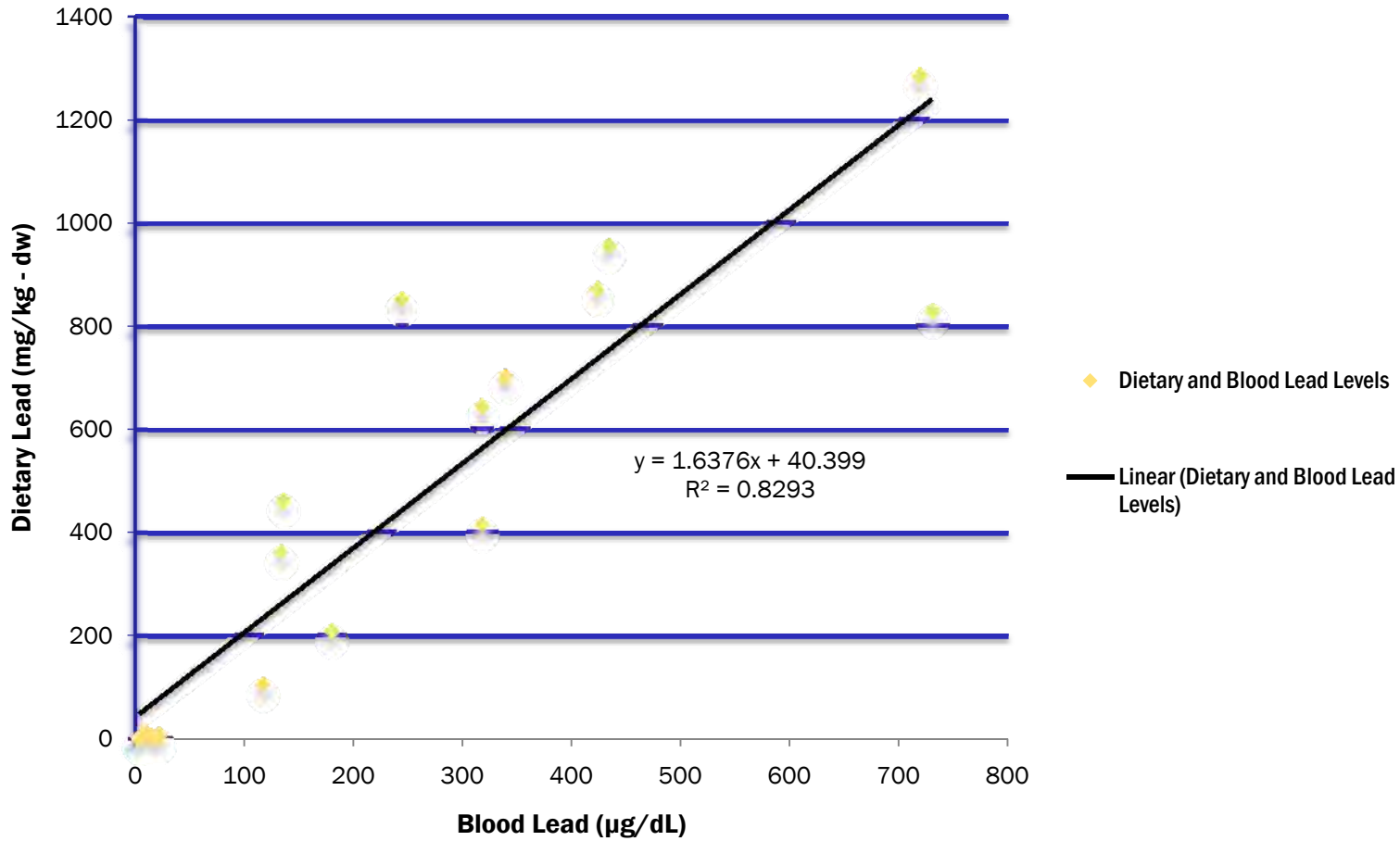
Figure C-1

Dietary Lead versus Blood Lead in Birds



Notes:

1. Data from Connor et al. 1994, Heinz et al. 1999, and Day et al. 2003.
2. Blood lead concentrations converted from µg/g-ww to µg/dL as follows: µg/dL = µg/g-ww * 106 g/dL (assuming a blood density of 1.06 g/mL).

Dietary Lead Versus Blood Lead Levels in Birds	
Engineering Evaluation and Cost Analysis Midway Atoll National Wildlife Refuge	
GeoEngineers	Figure C-2

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